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The Halen Reinforced-Concrete Bridge, Bern, Switzerland*

For a number of years efforts have been made to secure the erection of a high-level bridge connecting the suburbs of the city of Bern, Switzerland, with the isolated but populous country lying across the Aare River and to the northwest of the city. Finally in April, 1911, the Canton of Bern decided upon the construction of such a bridge, to be located at Halen about 2 mi. from the center of the city, and called for a limited competition for the design and the construction. As a result of this competition the bridge described in the following article was selected and work started in the Fall of 1911, with a contract for completion on Nov. 30, 1913. However, on account of the well planned execution of the work and the coöperation between authorities and contractor, the construction was so expedited that the bridge proper was completed practically a year before the contract date, though it will not be opened before next winter.

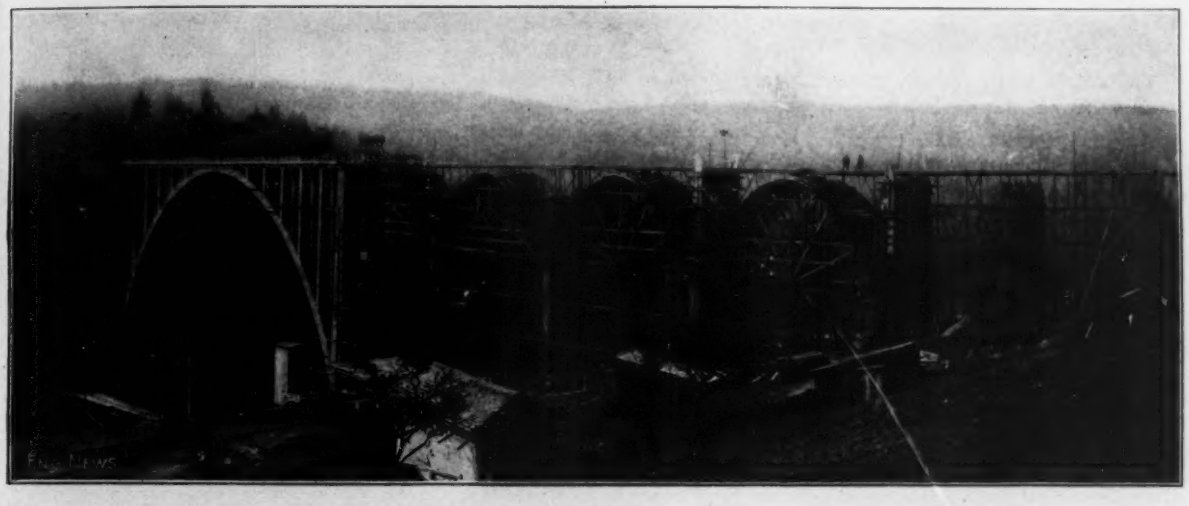


FIG. 1. THE HALEN BRIDGE NEAR BERN, SWITZERLAND, UNDER CONSTRUCTION
[Main arch 286-ft. span]

The structure is built throughout of concrete, reinforced where required. It is designed for highway travel only, with a distributed loading of 92 lb. per sq.ft. and a concentrated loading of a 10-ton four-wheel truck.

The Halen Bridge, shown in outline in Fig. 2, crosses the Aare with a single span of 87.15 m. (285.92 ft.) clear width, with the roadway crown about 40 m. (131 ft.) above mean water. The main span is flanked on the north bank by two girder spans each 10 m. (32.8 ft.) in the clear, and on the south bank by four arch spans of 21 m. (68.9 ft.) each and three girder spans of 10 m. (32.8 ft.), the last of these having been added in the course of 1912 as a partial substitute for the embankment of the approach roadway, which on account of unfavorable soil conditions proved to be undesirably high.

The bridge roadway actually slopes down from the center of the bridge on a 0.3% gradient. The deck of the bridge is 8.5 m. (27.9 ft.) wide between railings, comprising a 7-m. (23-ft.) roadway and a 1.5-m. (4.9-ft. sidewalk on one side only. The original project was for a location straight in plan, but in designing the centering it was found more convenient to deflect the alignment over the main span about 6° 30′ in order to get the pile bents of the centering more nearly parallel to the current and to give them a more favorable position with regard to the line of the skewback. The changed alignment, however, would have increased the length of the approach and made the gradient of the connecting roadway steeper. As a result the approach was located on a curve of 500 m. (1640 ft.).

FOUNDATIONS

The design had contemplated constructing the footings in the drift soil overlying rock. It was found, however, that this soil, particularly when wet, was not firm enough and, therefore, all piers and abutments were founded on bedrock (Molasse sand stone). On the north bank the work was simple as all foundations could be footed above river bottom. On the south bank, however, the foundation pit for the abutment had to be carried about 5 m. (16.4 ft.) under mean water level of the river as rock lay deeper than soundings had indicated. Al-

*The information from which this article was prepared was sent us through Mr. E. L. Corthell by Mr. A. Zeerleder, of the firm of Müller, Zeerleder & Gobat, of Bern, who had the contract for designing and building the bridge.

though the work was done at lowest water (December, 1911) and the pit was about 7 m. (23 ft.) distant from the shore line, a 50-hp. pumping plant with a centrifugal pump capable of discharging 1300 gal. per min. had to be used to keep the pit drained.

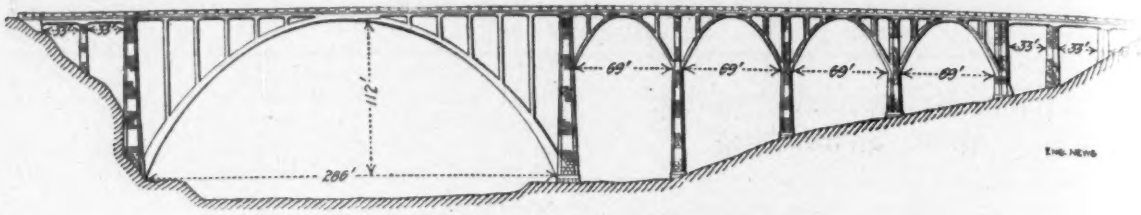


FIG. 2. ELEVATION OF THE HALEN BRIDGE

Three piers were founded directly on the rock at suitable height. Piers 4, 5 and 6 and Abutment 3, however, were founded indirectly on the rock by means of driven rails (80 lb. per yd.) 14 to 20 ft. long in foundation pit 10 to 17 ft. deep. The load per rail is about 22 tons. The load directly on the rock in all foundations was limited to 10 tons per sq.ft.*

PIERS AND ABUTMENTS

The design of the main abutment was intended to be made such that the resultant reaction at foundation level together with an arch opening. The distribution of the mass is such that the resultant of all forces at the foundation level makes an angle of only 10° with the vertical. The abutment on the north bank, which is founded directly in the rock and which above the skewback of the main arch is subjected to vertical load only, required but small weight for stability and could, therefore, have been made with T-shape sections. Esthetic considerations, however, dictated giving it the same external form as the south abutment. Besides the arch openings through the pier, there are in addition hollows in the interior of the pier for saving material.

The abutments as well as the intermediate piers were built of concrete blocks in courses 50 cm. (20 in.) high, alternating stretchers and headers with concrete backing. The blocks were molded, on a level spot at the foot of

FIG. 3. VIEW OF HALEN BRIDGE UNDER CONSTRUCTION

should depart as little as possible from the vertical, and at the same time the volume of concrete be kept down to a minimum. The design carries out the fundamental effect by heavy batters and ample horizontal dimensions, the bridge, from broken gravel and sand. They were not used until after at least 28 days moist storage. A rough exterior face was secured by covering the bottom of the form with rather coarse gravel. The good appearance of the faces of the piers is largely due to the surface thus secured.

*In the call for competitive designs for the Lorraine Bridge in Bern the same rock was permitted to carry a loading of 12 tons per sq.ft.

Main Arch Span

The main arch (Fig. 4) has a span of 87.15 m. (285.92 ft.) between abutments, a theoretical span of 85.6 m. (280.84 ft.) and a theoretical rise of 29.575 m. (97 ft.). The actual showing rise is 112 ft., as shown in Fig. 4. The stresses were calculated as for a fixed end arch without hinges, after the method given by Prof. Mörsch. Special pains were taken to make the neutral line of the arch coincide as accurately as possible with the dead-load pressure line.

The accompanying tabulation of stresses (Table I) will show that a slight reinforcement of the arch to take up a tensile stress of 3 kg. per sq.cm. (42.7 lb. per sq.in.) would be necessary in the lower third if the tensile strength of the concrete itself were wholly disregarded. Nevertheless, a full system of reinforcement was used in the arch just as was done by Prof. Mörsch at the Gmünd-

TABLE I. STRESSES IN 286-FT. ARCH

Lb. per Sq.In.
— = compression
+ = tension

		Dead Load	Live Load Temp.	Live Load Compression	Live Load Tension	Total Load Max.	Total Load Min.
Crown	Ext.	—203	± 53	—175	+ 83	—431	—68
	Int.	—248	± 56	—105	+ 148	—408	—44
Sect.	Ext.	—199	± 7	—157	+ 155	—363	—37
	Int.	—206	± 9	—185	+ 145	—400	—53
Sect.	Ext.	—213	± 34	—57	+ 60	—304	—120
	Int.	—185	± 33	—91	+ 44	—309	—108
Spring	Ext.	—230	± 51	—196	+ 125	—478	—54
	Int.	—188	± 51	—145	+ 179	—384	+ 43

back of the arch since then, it may be said that the method of construction employed was successful.

Centers were struck Aug. 15, 1912, that is after 40 days' time. It was done in the customary way by easing off the sand boxes from crown toward abutment. It developed that the adhesion of the centering lagging to the arch concrete was so great that the movable portion of the centering had to be driven down after partial

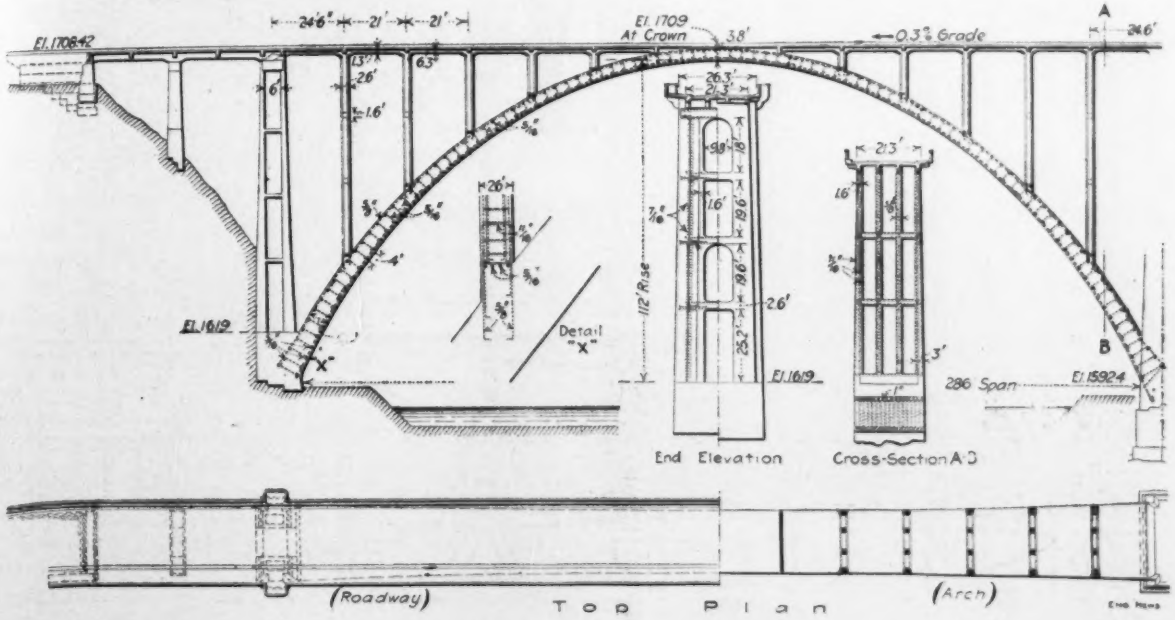


Fig. 4. Details of 286-Ft. Arch of Halen Bridge

nertobel bridge, and for similar reasons. The general distribution and amount of this reinforcement is shown in Fig. 4.

In conformity with the design of the centering and the arrangement of joints of the reinforcing bars, the arch was concreted in sixteen sections, each section representing a day's work. The whole concreting was done in the period from June 17 to July 8, 1912, that is in 23 working days. Daily level readings were taken on the panel points of the centering. A summary of the results is represented by the following: Total deflection of centering at crown of arch 65 mm. (2.6 in.), the deflection decreasing uniformly from crown to abutment. The crown having been given an initial camber of 100 mm. (4 in.) it follows that the actual arch at a temperature of 15° C. is within 35 mm. (1.4 in.) of the theoretical position of the arch. There being no other deformation either during concreting or after closure of the arch and no cracks having appeared in the emptying of the sand boxes by driving wedges between concrete and lagging.

Mortar tests of the cement employed showed a compressive strength after 28 days of 350 to 420 kg. per sq.cm. (4980 to 5980 lb. per sq.in.). Taking only half these values it may be assumed that the arch when centers were struck had a compressive strength of 170 to 210 kg. per. sq.cm. (2500 to 3000 lb. per sq.in.). Comparison with the dead-load stresses calculated for the arch shows a safety factor of 15 to 20.

The complete elasticity of the arch at the age of 40 days is shown by the fact that check levels on the crown of the arch after striking centers showed a rise of 7 mm. (¼ in.).

Approach Arches

The 21-m. (69-ft.) span of the side arches was dictated essentially by the topographic conditions. It was necessary to detail them in such a way as to minimize the arch thrust, particularly at the south bank. The

TABLE II. STRESSES IN SMALL ARCHES

Lb. per Sq.In.
— = compression
+ = tension

		Max.	Min.
Crown	Ext.	—320	+ 33
	Int.	—138	+ 147
Spring	Ext.	—505	+ 55
	Int.	—354	+ 219
Haunch	Ext.	—477	+ 90
	Int.	—102	—257

arches as well as roadway are, therefore, designed as light as possible, and the skewback placed quite low.

The calculation of stresses showed, as was to be expected, that the dead-load pressure line does not approximate a continuous curve, since in the main arch since the concentrated loads from the roadway columns are relatively much more important and the continuously distributed arch weights less important. Therefore, the arch curve could only be made to approximate the pressure line, but could not be made to coincide with it.

The determining stresses in the approach arches (stated without reference to the reinforcement) are tabulated in Table II. It may be seen that the stresses range from 35.5 kg. compression to 18.4 kg. tension (505 lb. and 257 lb. per sq.in., respectively).

The reinforcement of these arches consists of 32 upper and 32 lower 1-in. round rods connected by loop-shaped stirrups, arranged about as in the large arch shown in Fig. 4.

In arranging the concreting of the four approach arches the main abutment and Pier 4 were considered as abutment piers. As a beginning the first section of Arches 1, 2, 3 and 4 was carried up on both sides from the springing to about one-third the height of the pier, corresponding to a day's work. Then a section 6 m. (19 ft.) long at the crown of the arch was concreted, progressing from Arch 1 to Arch 4 and finally in the same order of progression the intermediate sections simultaneously on both sides. Concreting was begun Oct. 25, 1912, and was completed Nov. 10, 1912, in spite of very unfavorable weather conditions. This amounted to 17 working days. Levels taken on the panel points of the four sets of centers showed only very small deflections: 13 and 15 mm. (0.52 and 0.60 in.) for Arches 1 and 2; 6 and 11 mm. (0.24 and 0.44 in.) for Arches 3 and 4.

Roadway and Balustrade

The cross-section of the roadway is a continuous reinforced-concrete slab 16 cm. (6.3 in.) thick, supported by four longitudinal girders 2.08 m. (7 ft.) apart with cantilever extensions of about 1.20 m. (4 ft.) including the railing. Over main as well as approach arches the slab is carried by four reinforced-concrete columns in

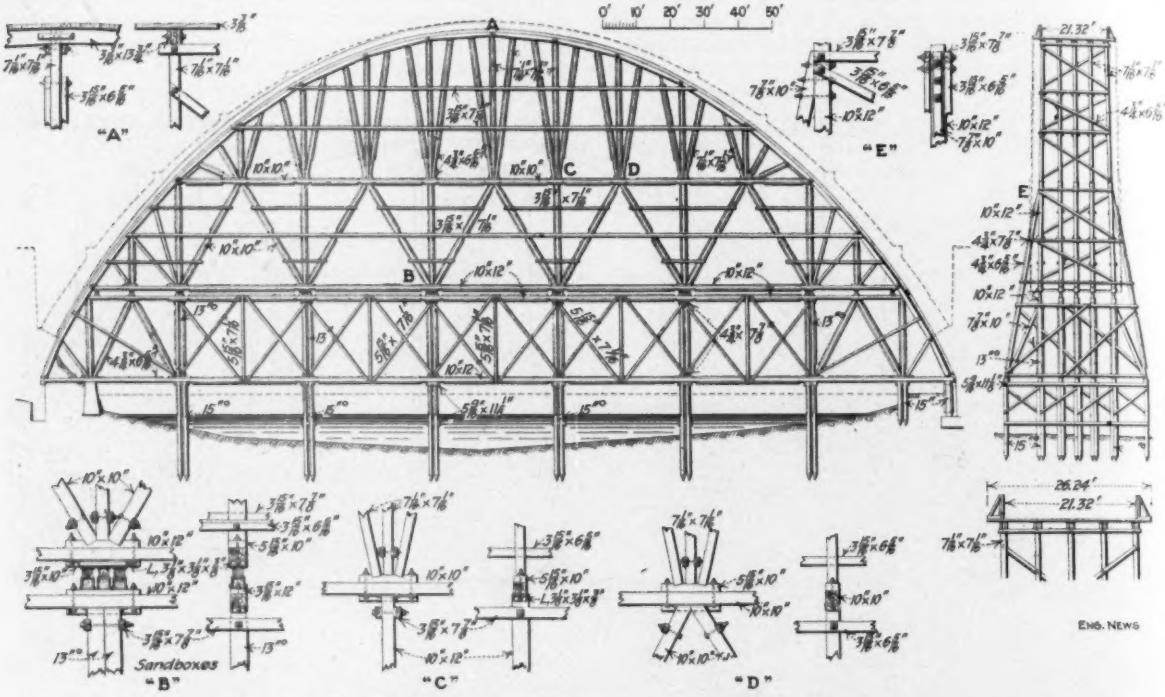


Fig. 5. Details of Centering for 286-Ft. Arch

each row corresponding to the four longitudinal stringers. Expansion joints with about 20 mm. (¾ in.) opening are provided over the two abutments as well as over the piers. These have an opening of about 20 mm (¾ in.) at temperature 50° C. to allow for a possible temperature increase of about 20° C. above normal. The ends of the stringers expand or contract on sliding joints. This design of expansion joint has the advantage of maximum simplicity and adequate mobility. The joints in the roadway are covered with slate 15 cm. (6 in.) wide laid in grooves in the concrete and sealed with tar.

The roadway slab has a convex profile corresponding to that of the roadway surface. The roadway itself is built of an average thickness of 15 cm. (6 in.) on the consideration that the hard concrete foundation makes unnecessary the customary thickness of roadway stone, which would only represent unnecessary loading and not increased wearing ability of the road. Therefore, the paving is built of a bottom course 10 cm. (4 in.) thick of large stone laid by hand, covered and rolled together

with a 5-cm. (2-in.) layer of small broken stone and sand.

For drainage of roadways and sidewalks the slab and arch have openings 15x15 cm. (6x6 in.) at suitable intervals with cast-iron catch basins 24x24 cm. (10x10 in.) in the gutters of the roadway. The drip from these drains is carried down to the back of the main arch by leaders set in the angle of the outer roadway column and from the bottom of the leader a spout carries the water off laterally. The drain elsewhere than on the main arch could be discharged directly clear of the structure.

A layer of waterproofing is laid over the roadway slab and under the metalling. Water percolating through the pavement or sidewalk is carried along the top of this layer to the drain openings and thus discharged.

The balustrades are built of reinforced concrete and consist of piers 20 cm. (8 in.) thick which were concreted with the roadway slab and anchored to it and perforated slabs between these 9 cm. (3½ in.) thick, and a hand rail of 10x20 cm. (4x8 in.) in section. The perforated plates are set into trapezoidal grooves in the piers. Before molding the slabs in these grooves were painted with hot tar to prevent temperature cracks. The handrailing was molded in pieces 1.50 m. (5 ft.) long and set in place after hardening for several weeks.

Centering of Main Arch

The design and construction of the centering for the main arch was given most careful attention on account of the importance of this part of the work with respect to maintenance of true arch forms and with respect to cost.

The necessity of minimizing the deformation of the centering during concreting led to the rejection of all flexible styles of centering such as are used with stone bridges employing arch framing, etc. Further, the supervision by the authorities of the Canton of Bern had prescribed a minimum spacing of 12 m. (39.4 ft.) for supports placed in the bed of the river.

Using this minimum bent spacing of 39.4 ft. and a maximum compression in the timber of 40 kg. 569 per sq.cm. the centering was designed as a simple braced trestle as shown by Fig. 5.

The fixed portion of the framework consists of six pile bents, each comprising three quadruple and two triple pile groups together with an upstream and a downstream single pile to support the lateral shore; that is, 20 piles per bent with the necessary 14x28 cm. (5.6x11.2 in.) and 8x12 cm. (3.2x4.8 in.) braces. On each bank a concrete temporary pier was erected for supporting the lower story of the falsework. The piles are of minimum diameter 38 cm. (15.2 in.). Each pile group was to carry a total load just before closure of the concrete arch including the dead weight of the timber work of 67 to 70 tons, or a load of about 17 tons per pile. That this is smaller than the elsewhere customary loading of such piles with 25 tons is due to the uncertainties of the foundation soil and the serious consequences of any yielding of the piles. In view of the great dimensions of the structure it might be necessary to count the whole load of a group as coming on two or three piles.

The pile groups were connected at the top by horizontal struts 25x30 cm. (10x12 in.), which were stiffened to take compression by channel and angle irons as shown in Fig. 5. The tops of the pile bents were set 1 m. (3.3 ft.) above highest water of the river. Upon them is set the upper story of the fixed portion of the centering 8.5 m. (27.9 ft.) high. The frame bents of this story consist of uprights each made of two 32-cm. (13-in.) round sticks coupled together, with a diagonal bracing of bents longitudinally and laterally. On these columns rest the main longitudinal sills 25x30 cm. (10x12 in.), on which were seated the 100 sand boxes in groups of two or three.

The upper or movable part of the centering consists of two stories 10.6 (52.5 ft.) and 14.2 m. (46.6 ft.) high. The posts of the two stories are 25x30 cm. (10x12 in.) and 18x18 cm. (7.2x7.2 in.). The sections being so proportioned that throughout the entire falsework the posts carry a uniform intensity of compression, and the column lengths in all cases were limited by lateral and longitudinal bracing struts.

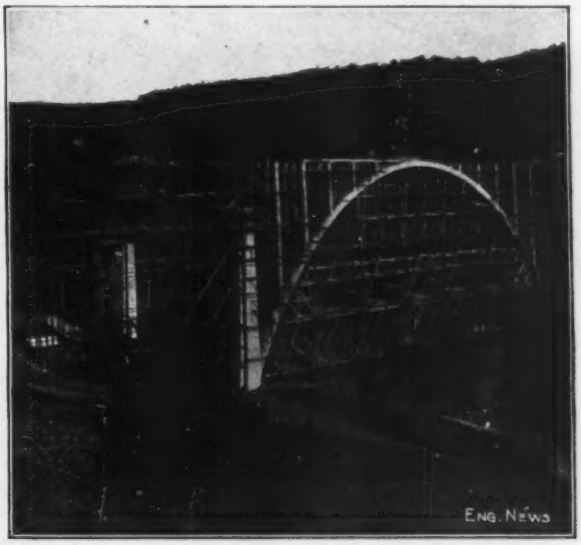


Fig. 6. The Halen Bridge under Construction, Showing Centering of Main Arch

[Note that this centering is designed so that the upper part could be used in two of the smaller arches and the lower part in two others. The falsework under these smaller arches is shown in the first page view.]

The outer planes of the falsework were set to the batter of 1 to 50 of the arch faces instead of vertical. This arrangement secured a great saving of timber and increased the stability of the centering. These inclined frames were connected across the centering by ample timber ties to neutralize the lateral thrust.

The joints of the centering were detailed with hardwood and channel-iron sections. By this means and by accurate framing a special effort was directed toward minimizing the settlement of the falsework, efforts which proved successful as shown by the very small deflection above recorded.

The nature of the design of the falsework called for unusual lengths of beams, 10 to 14 m. (33 to 46 ft.). On this account the timbers were required to be rigidly of the full ordered dimensions.

For laying out and framing the arch a lot near the site of the structure, 100x50 m. (328x164 ft.), was accurately leveled off and the arch staked out by transit, using a coördinate method with chord distances of 2 m.

(6.6 ft.) measured along the span. The arch points fixed by the stakes were then connected by arcs laid out to the appropriate radii of curvature. This method is to be recommended for laying out large arches everywhere where conditions do not permit a direct layout from the centers of curvature. In laying out the two outer battered frames of the centering the layout floor was set to the proper batter by blocking up and thus the framing could be accurately fitted to the batter.

The framing of the falsework had to be done in winter to permit of proper completion of the construction work. For this reason a lighting plant was put in on the framing floor, comprising ten 500-cp. incandescent lamps, six of these on the framing floor and four at the bridge site.

The material required for the center of the large arch was 1633 M. b.m. of lumber and about 16 tons of iron and steel.

In taking down the centering, all the 120 piles of the pile bents were drawn together, with their pile shoes, by winches set on two coupled scows. No pile stumps or the like remained to obstruct the channel or threaten the safety of shipping.

Centering of Approach Arches

For reasons of economy the specifications required that the approach arches should be built only after completion of the main arch, so that timber, iron and sand boxes of the main arch centering could be used for the side arches. Further, the centering of the side arches was to be designed in such a way that the upper part of the main-arch centering which was first taken down could be used in the side arches. A requirement of different kind was that particular care was to be given to securing absolute rigidity of the centering of the side arches, as the arch ring thickness was to be very small and even small deformation would affect the stresses in the concrete quite materially.

For this reason Arches 3 and 4 were designed for use of the long and slender 18x18-cm. (7.2x7.2-in.) posts of the upper story of the main-arch centering. They were, therefore, designed for a radial post centering frame. On the other hand, Arches 1 and 2 had their centering designed for use of the heavy posts of the lower story of the main-arch centering and the design was worked out as a combined cantilever and arch frame supported on broad 12-in. I-beams set into the piers at the spring line and removed after striking centers. The general design of these centering frames may be noted in the view in Fig. 1.

Contractor's Plant

Most of the sand and gravel used for the bridge was taken from the Aare River. The handling and mixing plant, comprising crushers, gravel, washing and sorting machines and concrete mixers, was set up on a meadow on the south bank of the river near the bridge site. In the winter of 1911-12 a large stock of gravel from the river was accumulated there.

Concrete was handled from the mixer to the place of use by narrow-gage cars which were run to two structural-steel hoist towers about 40 m. (131 ft.) high and there hoisted and run out on tracks at any of the several stories of the material scaffold. These elevators were served by electric hoists. The plant involved rather high first cost as compared with other systems of handling, but had the advantage of simplicity of manipulation and complete reliability and the further advantage of large capacity. In concreting the main arch the plant was worked up to 90 and 100 cu.m. (120 and 130 cu.yd.) per day.

Electric power was furnished by the local electric company through a transformer station at the site.

The stone crusher, gravel washing and sorting plant and the concrete mixer were operated by a 25-hp. motor and on either side an 8-hp. motor was set up for operating an elevator hoist. The main motor could also drive a reserve saw mill for working the form lumber.

On the left bank of the river a second plant was set up, comprising a gravel washing and sorting drum, a small crusher and a concrete mixer driven by a 10-hp. motor. A storage pile of bank gravel and sand on that side of the river was worked up by this second plant.

Water for washing the gravel and for concrete mixing was taken in part from a concrete reservoir constructed on the right hillside and partly from a small pond made by damming a nearby ditch.

Quantities and Cost

The bridge involved the following quantities:

Foundation excavation	2220 cu.yd.
Foundation concrete	1180 cu.yd.
Steel rails in foundation	1740 ft.
Piers and abutments, except foundations	4350 cu.yd.
Main arch concrete	1570 cu.yd.
Concrete in small arches	460 cu.yd.
Reinforced concrete of roadway and columns	1220 cu.yd.
Filling concrete over arches	240 cu.yd.
Reinforcing steel about	121 tons

The first appropriation for the bridge was for a total cost of 480,000 fr. ($96,000) for the bridge without roadway approaches, but including cost of land and supervision, besides contract cost of structure. The foundation work, however, turned out to be more costly than foreseen and the price of cement ruled higher than taken in the estimate. The total cost will, therefore, be somewhat above the sum mentioned. In comparison with other similar structures in Europe the cost of the Halen Bridge—with its length of about 787 ft., a height of about 78.7 ft. above water, and a roadway width of 27.9 ft. between railings, will be found to be low.

The bridge will be opened for traffic before the opening of the Swiss National Exposition, 1914. It is expected that the roadway approaches will be completed by that time also. As the bridge is only about a mile from the exposition grounds and a walk through the Bremgarten woods through which the approach road passes is one of the finest pleasure excursions in the attractive environment of Bern, it is to be expected that numerous visitors to the exhibition will pay a visit to this bridge, at present the largest concrete or reinforced-concrete bridge of Switzerland.

Personnel

The responsibility for the structure rests mainly on the contracting firm which won the competition and which has had complete charge of the work, but a number of interested parties were represented by engineers who are also partly responsible for the structure.

The contract was awarded to Müller, Zerrleder & Gobat, of Bern. The statical calculations and the execution of the reinforced-concrete work were undertaken by J. Bollinger and Favre & Co., both of Zurich. The checking and examination of the design was entrusted to Prof. Schnyder, of Burgdorf. The supervision of con-

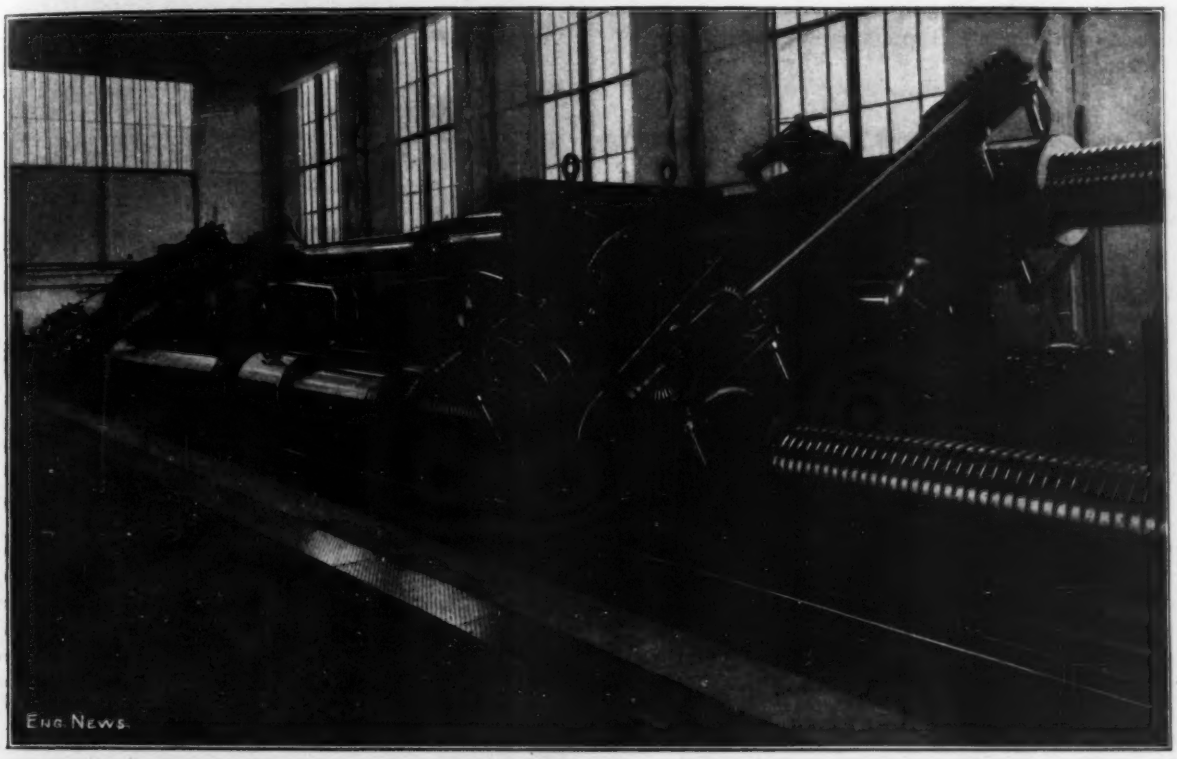
struction was in charge of Engineer Meyer, of Thun. In addition to these engineers, the so called Promotion Committee, which long urged the construction of the bridge, was represented by Grossrat Atler and Nationalrat J. Lanz and the Canton of Bern, which subsidized the structure, by Regierungsrat Könitzer and later by Regierungsrat R. von Erlach.

The 3300-Ton Testing Machine at Berlin

The great material-testing institution of the Prussian government at Gross-Lichterfelde, near Berlin, now possesses the largest testing machine capable of both tension and compression testing in the world. This machine, of 3300 tons compression capacity and 1650 tons tension capacity, is shown in the two accompanying photographs for which we are indebted to the courtesy of Professor A. Martens, Director of the laboratory. The size of the machine may be estimated by comparison with the size of the man shown standing alongside. General drawings of the machine were given in our issue of May 2, 1912 (p. 841).

This machine is of the hydraulic type, and has no weighing head. It was built by Haniel & Lueg, of Düsseldorf, to the order of the association of German bridge manufacturers, who also paid for the building which houses the machine. It was designed and built specially for the purpose of making tests of a series of large-sized bridge members and details. Some important tests have already been carried out with it, for example, tests of riveted joints, one result of which was the abolition of the small triangular fillet between head and shank of rivets, which has been in use in Germany for a number of years past.

In general type the machine is, with one exception, not greatly different from the older and very much smaller horizontal machine of the Gross-Lichterfelde Laboratory, built to Professor Martens' design. The exception is the position of the screws. Prof. Martens recommended that the pair of screws be placed in an inclined instead of a horizontal plane, putting the front screw down near the floor and the rear screw correspondingly above the center, so as to make the working region of the machine more readily accessible. The recommendation was followed, and actual use has fully demonstrated its value.



THE 3300-TON TESTING MACHINE OF THE KÖNIGLICHE MATERIALPRÜFUNGSAMT, GROSS-LICHTERFELDE, BERLIN, GERMANY

(The largest testing machine in the world. It has two-thirds the compression capacity of the 5000-ton press of the Bureau of Standards, and about three-fourths the tension capacity of the Ambridge eyebar machine. Both of these American machines can test in one direction only. The largest general testing machines in America are the Phœnix hydraulic machine and the new Emery machine of the Bureau of Standards, both of 1200 tons capacity.)

Comparative Salaries of Executive, Legal and Engineer Officers of a Rapid Transit System—During the recent hearings in Boston, Mass., to take evidence on the recent controversy between the Boston Elevated Ry. Co., and its carmen the following facts were brought out in regard to the salaries of the various officers of the company, which are interesting to engineers for comparative and contemplative purposes: The salaries are: President, $36,000 per annum; First Vice-President, $20,000; Second Vice-President, $15,000; Treasurer, $12,000; Real Estate Agent and Asst. Secretary, $10,000; Clerk, $10,000; General Auditor, $7500; General Counsel, $25,000; Assistant Counsel, $15,000; Publicity Agent, $4000; Chief Engineer, $9500 per annum.

Teaching Mathematics to Engineering Students

By Willis Whited*

I am not versed in the technique of teaching, but it has been my duty and privilege to have more or less to do with training a number of technical graduates in engineering work, and I would offer the following suggestions as to the teaching of pure mathematics:

When a young man is in college, nobody can tell what branch of engineering he will follow in after life, nor even whether or not he will follow engineering at all. He has seldom developed his peculiar talents and weaknesses and besides, much depends upon his surroundings and opportunities, as he grows older. An engineering education is very useful to a great many men who never engage in actual engineering work, and the undergraduate never knows but that he may be one of that class. Confining ourselves to those who follow engineering as a life business, I would say, personally, that I would much rather take into my office a young man who is well grounded in mathematics and the sciences upon which engineering is based and who is comparatively ignorant of practical details, than one whose preparation is the reverse of this. It is more trouble to "break him in," but he is much more useful in the long run. He is much better able to keep up with the advance of his profession. The practical details that a young man learns soon become obsolete but his science does not, although the elementary principles of today may be the special cases of tomorrow.

Engineers use mathematics (1) in doing routine work; (2) in reading engineering periodicals and books and, (3) in making original investigations.

(1) For the first purpose quite a moderate equipment is sufficient. The engineer engaged in routine work should be quick and accurate at figures and be thoroughly versed in the various methods of proving his calculations, although the wide use of the sliderule and various mechanical calculators reduces the demand for the skill of the "lightning calculator." He seldom uses much algebra, rarely going beyond the equations of the second degree, except that he must be expert in the use of logarithms. His sliderule is based on logarithms. Most of his plane and some of his solid geometry, he must "know by heart" and he must be expert in solving various kinds of geometrical problems. He has constant use for elementary plane trigonometry, and a knowledge of elementary spherical trigonometry is very useful in certain kinds of work. For most purposes it is far better for the teacher to treat a spherical triangle as a trihedral angle than as a part of a sphere. As to analytical geometry, the engineer seldom uses the equation of a straight line or a plane but he often has to represent rules, formulas and results of experiment by graphs, and a knowledge of the properties of the conic sections is often required. Calculus is seldom used directly, but mensuration and other rules based on calculus are used extensively. I think teachers should place more stress on mensuration, including the barycentric method, not forgetting that the volume of a bar of uniform cross-section, is equal to the product of its sectional area into the length of its center of gravity, whether its axis is in the form of an arc of a circle or not. This applies to bent bars of metal and to fillets on castings.

Drafting is essentially an application of descriptive geometry, and some draftsmen have to make perspective drawings, although few draftsmen could solve many of the problems in Church or Warren. Nevertheless, every engineer should have a thorough knowledge of elementary descriptive geometry and be able to construct oblique sections and projections and develop cones and cylinders if necessary. Some special lines of engineering require a knowledge of other branches of pure mathematics—spherical harmonics, probabilities, etc.—but the men who do that kind of work are hardly routine engineers.

(2) Modern writers on engineering subjects use advanced mathematics much more freely than the older ones, partly because they understand it better themselves and partly because a much larger proportion of their readers are college men, than formerly. The mathematics taught in the undergraduate courses of most technical colleges is sufficient to enable the engineer to read nearly all current engineering literature. It must be borne in mind, however, that the student of today will be the engineer of 1950 and must be prepared to hold his own. If I may hazard a guess, I would say that future writers will use multiple integrals and differential equations, including spherical harmonics, etc., determinants, vector analysis, projective geometry and complex functions, much more freely than at present. At all events the engineer who hopes to keep up with the progress of his profession must be prepared to take up new branches of mathematics as he finds it necessary.

(3) Regarding the engineer's mathematical equipment for original investigation, all depends on how his work develops. I would, however, venture the following suggestions: Advanced arithmetic will frequently be useful. He will have little use for any branch of algebra beyond equations of the second degree, except logarithms and Horner's method of solving higher equations. Series is a very extensive and difficult subject and most cases must be treated by special methods. Complex variables will occasionally occur and a reasonable knowledge of what to do with them can easily be acquired. Determinants will occasionally be useful and the main principles are easily learned.

He will seldom have use for analytical geometry except the general principles and curves and surfaces of the second degree. Other curves can better be handled by calculus.

He will need elementary geometry and trigonometry at every turn of the way and those two branches will become almost second nature to him. Projective geometry will occasionally be useful, if he employs graphical solutions very much, but it is a rather difficult and extensive subject and is of little use unless he is in reasonably constant practice. It is a very interesting subject and contains many beautiful theorems and solutions.

I look for vector analysis to be employed more extensively as mathematicians become more accustomed to its use. The elements of it may be acquired in a very short time, but, like most other tools, skill comes only with long practice.

Calculus is a very powerful reasoning engine and will be used more and more as engineers become accustomed

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to it. Nobody is prepared to place any limitations on its usefulness. The investigating engineer will have more or less use for nearly all the differential calculus that is commonly taught in college and he should acquire as extensive a list as possible of formulas for integration, including hyperbolic functions, and a good understanding of the principal methods of approximate integration. Newtonian potentials, Eulerian integrals, elliptic functions and Abelian integrals are very extensive and difficult subjects and at best only give rise to special kinds of transcendental functions which can best be evaluated by approximate methods, and appear to be hardly worth the time of any, except the professional mathematician.

Differential equations are much used in some kinds of work, but it is a very large subject and each problem must usually be treated on its merits. Comparatively few can be solved at all in the present state of the art and I have not heard of any approximate methods that can be used in an emergency. I hope some of the younger mathematicians will take up this subject. Spherical Harmonics and similar methods are often used for the solution of differential equations.

Calculus of variations may some day be developed so as to be quite useful, but at present it appears to be of very limited application in engineering.

Quite an extensive literature, mostly in French and German, has appeared in the last few years on the theory of functions both of real and complex variables, the principal aim of it being to place algebra and differential calculus on a more logical basis. It is a beautiful subject, but what little of it I have read does not appear to lead anywhere that the older books have not gone, and I would hardly recommend its study to the busy engineer, as much time would be required for its mastery.

Other branches of mathematics may be useful at times, and some branches which now appear to be little more than mathematical gymnastics, may, later, be so developed as to be quite useful.

The program laid out above, is much more than any student should be asked to cover in an undergraduate course, and in fact, only the exceptional man needs more than a fraction of it. Besides, no undergraduate student, nor his teacher, can tell how much of it he will need. As to the mental discipline there is little choice except that Euclidian geometry cultivates the student's powers of formal logic, algebra and calculus his powers of abstract thinking and descriptive geometry cultivates his powers of imagination. Otherwise, it makes little difference what branches he studies.

I would further call attention to the following points: It is hardly fair to force all students to take studies which are of use only to the exceptional man. The subjects which the student is likely to need, but will probably never know, unless he learns them in college, should be taught there more or less thoroughly.

No student can, at the best, cover more than a small portion of the branches that are likely to be useful to him.

It is hardly necessary in teaching those subjects which are not universally necessary, to drive them home too strenuously by numerous problems, etc., because if the man uses them much later in life that use will give him skill; otherwise it is a waste of time. Bibliographies are useful, but are apt to be obsolete by the time the student needs them, i.e., the periodicals are inaccessible and the books are out of print, and have been succeeded by better ones.

In the case of subjects which cannot be taught thoroughly for the lack of time, but which may be useful to him later in life, a synopsis giving its general character with proper bibliography and the purposes for which it can be used can be presented in the form of lectures, of which the student should be required to take full notes.

Students should always be given to understand that they are only acquiring the rudiments of their studies and that the higher branches must be learned later, as the occasion requires.

The exceptional student should be assisted, if necessary, to take post-graduate courses to fit him better for his special work, although too much teaching is liable, in some cases, to injure his originality and initiative.

I think many teachers require their students to commit to memory too many mathematical formulas and physical constants. Whatever of these the engineer uses frequently he will remember, while as to those he seldom uses he should refresh his memory, in any event, before he ventures to use them, because the human mind is so prone to remember things wrong. Peoples' lives or fortunes often depend upon an engineer's calculations; he should, therefore, take no unnecessary chances.

Much of the advanced work that I have mentioned above will probably be of no use to the young engineer for some years after graduation. After he has forgotten all about it, something may turn up that would render a knowledge of it very useful. I would suggest that the efforts of the teachers of such subjects should be directed toward enabling the student to recover the thread of the matter as quickly and as easily as possible, after a long interval of time when he has forgotten the details. For this purpose a few striking examples illustrating the main principles, would do more good than to wade through a mass of intricate details that he cannot hope to remember.

Engineering graduates should be equipped with what might be called emergency mathematics; i.e., methods for approximate integration, such as Cote's method, as well as methods for the solution of transcendental and other equations—double position, graphical solutions, etc.—the aim being to place him in such a position that he need not be baffled by any problem for which he can find a complete mathematical expression. The engineer is sometimes confronted with problems so important that they must be solved regardless of time and labor; in other words, the engineer cannot afford to "get stuck."

I think mathematicians should develop more completely the methods for approximate integration and the solution of transcendental equations which cannot be solved by ordinary methods. Such problems are very numerous. If some approximate solutions of as large a class as possible of differential equations could be devised, it would be very useful, as only a small proportion of such equations yield to the common methods.

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Landscape Architecture at Panama has reached the dignity of a special force, a fact significant of the nearing completion of the work. The "Canal Record" states that

the organization in connection with the work, other than building, at Balboa has been approved, and includes a landscape architect, junior engineer, transitman, two rodmen, two draftsmen, one general foreman, three subforemen, and 300 silver laborers.

New Coal Classification Yards of the Philadelphia & Reading Ry. at St. Clair, Penn.

By Joseph S. Ward*

Of the anthracite coal fields of Pennsylvania, comprising nearly 500 sq.mi., more than one-half, or about 275 sq.mi., are tributary to the lines of the Philadelphia & Reading Ry. Co.

This territory, practically all of which is within the limits of Schuylkill, Northumberland, Columbia and Dauphin Counties, is divided into two districts, the "Western Middle" or Mahanoy & Shamokin field and the "Southern" or Pottsville field. It is bounded on the east and west by the Schuylkill and Susquehanna rivers, respectively, and on the north and south by Shamokin and Swatara creeks.

These areas produce about 1,000,000 tons a month, or 25% of the total anthracite output. The mountains which encircle them have a general elevation above tide of 1500 to 1700 ft. The interior basins are broken with hills and ridges only a couple of hundred feet lower; and the narrow intersecting valleys with steeply sloping sides are not infrequently disturbed and often precarious by reason of the underground mine workings.

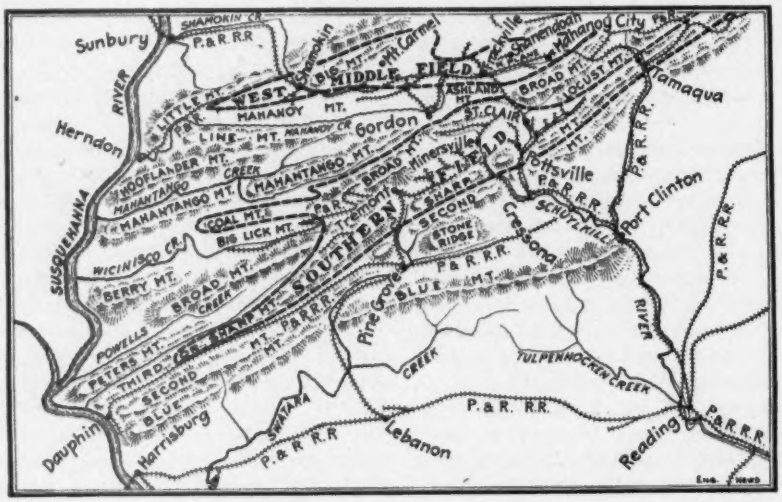

FIG. 1. SKETCH MAP OF THE WESTERN, MIDDLE AND SOUTHERN ANTHRACITE COAL FIELDS AND RAILWAY LINES ENTERING THEM

They are covered with a complex network of railways which penetrate the ravines or cross the crests, the location and character of which have necessarily been adversely affected by the great variety of contour. The watershed summits, steep slopes and narrow valleys have been productive of very heavy grades, in many cases opposed to traffic, and the alignment of tracks, most of which were located during the early days of railroad construction, is usually tortuous. The obstacles to railroad location and operation, offered by this rugged country are crudely illustrated by the sketch map of these anthracite fields shown in Fig. 1.

The principal distribution points for the Reading product, Cressona and St. Clair, are both in the Southern field. With the exception of a comparatively small proportion from the Tremont and Minersville regions, the output is assembled at and distributed from St. Clair and approximately 75% of this tonnage, originating in the Mahanoy and Shamokin valleys, is carried to the top of Broad Mountain by an inclined plane, and thence down its southern slope by a 3% grade, 5.5 miles to St. Clair.

The collection and distribution over both fields of an average of 1000 empty cars daily, the assemblage, classification and dispatching of an equal number of loaded cars within the same period, and the retarded movement due to the adverse conditions described present a problem in operation and transportation to the solution of which in a more expeditious and economical manner, the Reading Company has given exhaustive study for many years.

The Mahanoy inclined plane built in 1862 to handle the very small cars then in use and remodeled in 1884, was severely taxed by the abandonment of Gordon plane in 1895; and, with cars of constantly increasing capacity and a greater volume of business it has been possible, during the last decade, to hoist the output only by continuous operation of the plane during the 24 hours of each day.

After careful consideration of the many proposed low-grade routes and yard locations by which it was thought coal transportation might be effected with greater economy and dispatch, comparison of their supposed advantages with those of the older lines and close examina-

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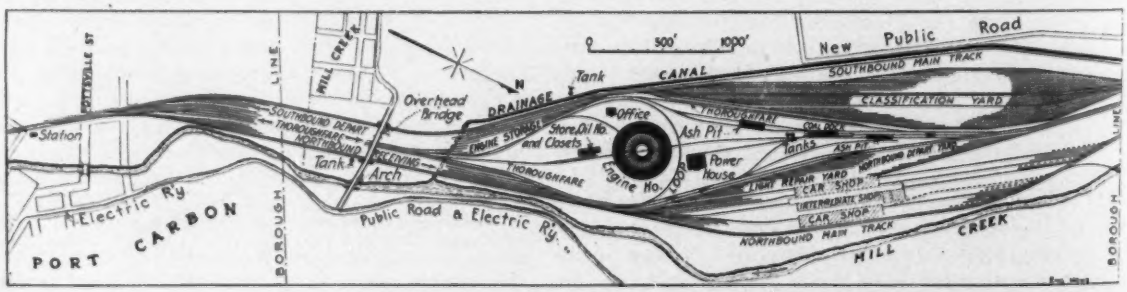


FIG. 2. MAP OF THE NEW CLASSIFICATION YARDS OF THE PHILADELPHIA & READING RY.

of the relative costs for construction, betterment, maintenance and operation, the continuance of present operating methods was decided upon in the early part of 1909.

This determination made imperative the immediate provision of more adequate facilities at St. Clair and an increased capacity at Mahanoy plane. The rehabilitation of the plant at the last named point, started in the spring of 1910 and completed in the late summer of 1912, a description of which will appear later in a separate paper, has been successfully accomplished with most satisfactory results. Its capacity has been more than doubled, the average daily hoist having been increased from about 30 to 76 cars per hour, and a maximum of nearly 100 cars has been attained under very favorable conditions.

The St. Clair Yard

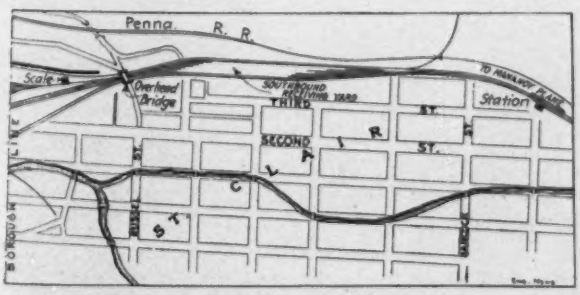
The exceptionally favorable and almost ideal site offered for classification purposes by the valley of Mill Creek, northeast of Pottsville, between Port Carbon and St. Clair, was probably the most important factor in the determination to continue at this location the new yards, the construction of which was started in May, 1909, and is now very nearly completed.

This valley, a little over two miles in length, with an approximate width of 1200 ft., offers natural grades admirably adapted to the classification of loaded cars by gravity, with no necessity for a "hump," at a minimum cost for grading, and in no way prohibitive of easy movement of north-bound traffic, which consists almost entirely of empty cars returning to the mines.

South-Bound Yard—This yard, comprising receiving, classification and departure tracks, starts a short distance south of St. Clair station, where the double tracks diverge from each other and continue southward, and these main tracks form the exterior limits of the yard to a point north of Port Carbon station. By this arrangement there has been assured a minimum interruption of traffic over the main tracks, by infrequent switch connections and yard movements.

The south-bound receiving yard, 2300 ft. in length, between St. Clair station and Russell St. overhead bridge, has, in addition to the two main and thoroughfare tracks, 8 parallel sidings with capacity for as many trains, or 280 cars. At Russell St., these eleven tracks are reduced to five, including two main tracks, scale track and connections to north-bound departure, repair, ash-pit, coal dock and engine-house tracks.

From the south end of the scale 570 ft. below Russell St., the south-bound classification yard of 35 parallel tracks of different lengths, in series of seven each, separated by 11-ft. spaces between outer rails, and with capacity for 1525 cars, extends southward 3500 ft., connecting with a single track 200 ft. in length, leading to the south-bound departure yard.



At Port Carbon and St. Clair, Penn.

This yard of nine parallel tracks, spaced 15 ft. centers, piped throughout for air at 110-lb. pressure and having a capacity of 75 cars each, with engine and caboose, and a total length of 3800 ft., terminates at Pottsville St., a short distance north of Port Carbon station.

A caboose track, which will accommodate 40 cabin cars, lies east of and parallel with the lower end of the classification yard, and the thoroughfare track above-mentioned runs the full length of the yard, east of the classification and departure yards. But six of the nine departure tracks have so far been constructed; the grading for the other three, however, has been completed.

Immediately east of the classification yard, between it and the north-bound departure yard, are located two sets of three tracks each, which serve the coaling station and ash pits. To these are connected other tracks, passing through the engine house to the power house and to the north-bound receiving yard.

A loop track, concentric with the engine house, joins the north- and south-bound yards at points opposite their north and south ends, respectively, and also serves as a Y.

The loaded trains of 33 cars each, descending the 3% grade from Mahanoy plane, are placed on the receiving tracks, from which, after inspection, they are shifted, one at a time, a brakeman being assigned to each car, either to the repair yards or over the scale for weighing, to their proper places in the classification yard. From the classification yard, the south-bound movement continues by gravity, the cars being dropped in drafts of 10 to 65 and assembled in trains on the south-bound departure tracks, whence, after inspection, charging with air, etc., they are in condition for main-line movement.

North-Bound Yard—This yard, commencing at Pottsville St., Port Carbon, comprises north-bound receiving, north-bound departure, and thoroughfare tracks, from which connections at the north end lead to loop, coal-dock and ashpit sidings and also the light, heavy and intermediate repair yards. The receiving tracks, parallel to and of equal length with those of the south-bound departure yard, are nine in number, six of which have been finished, for the other three of which the grading has been completed, and each of which holds a full main-line train.

The north-bound thoroughfare track reaches from the Port Carbon end of the yard to a connection with the south-bound "thoroughfare" near Russell St.

The departure yard, connecting at its south end with the receiving tracks and at its north end with the north-bound main and thoroughfare tracks, is located immediately east of the lower end of the classification yard. It has a total length of 2700 ft. and 12 tracks, six of which are to be used for light repairs, with a capacity of 720 cars.

Between this yard and the north-bound main track lie the heavy and intermediate repair yards of 8 tracks each, with equal lengths, and a capacity of 800 cars. Ten of these only are to be completed at this time, although grading for the other six is practically finished, and, at present writing, about 95% of grading and track work for the entire yard has been completed, the only unfin-

ished work being that incidental to tracks and grading through and adjacent to the proposed car shops.

Main-line trains of empty cars, after inspection in the receiving yard, are shifted by pushers to the departure or repair yards from which they are later taken in drafts of 15 cars up the heavy grade to Frackville and Mahanoy plane.

Between the north-bound departure and south-bound receiving yards there are four tracks for the storage of engines, having a capacity for 35 locomotives, and connected at their north and south ends to the engine house and thoroughfare tracks, respectively.

The south-bound profile, which conforms closely with that of the natural ground surface, has a grade of 1.2% for receiving and classification yards and 0.7% for departure and inspection sidings. The north-bound yard maintains approximately 0.7% and 1.0% grades for its receiving and departure ends, respectively, with such distortions, not exceeding 1.5%, as are necessary to reach the depressed tracks at the car shops.

All the track work and grading has been done by the railway-company forces. The receiving yard, the construction of which was begun in May, 1909, was completed and put in operation the following fall. Work upon the classification, two departure and repair yards, which started in April, 1910, was finished and the tracks in service by July, 1911. At that time all tracks in the old yard had been abandoned and construction of the unfinished portion of the north-bound yards was well under way. This has since been completed and put in use with the exception of those tracks proposed through and adjacent to the car shops, and upon their installation, the entire new trackage system of 45 miles will, without doubt, be in service before the close of the current year.

By the gradual removal of the old tracks and the immediate operation of those newly built in their place, construction has proceeded without interruption of normal traffic, in fact it has been handled during the whole construction period with regularly increasing dispatch. At this date, yard and train men are perfectly familiar with the new system, which, while not entirely completed, has effected a great saving of time.

Main line, ladder, lead and running tracks have been built of 90-lb. rail, with standard angle plates; 79- and 76-lb. patterns were used for other tracks; ties are untreated and of chestnut, oak and pine timber. Main-track connections have No. 10 frogs, 20-ft. switches, and are of standard build; other turnouts and crossovers have No. 8 frogs and 15-ft. switches; all are tie-plated on sawed timbers and are operated by low-type switch stands. Ladder angles vary from 1:6 to 1:8.

The grading, practically all of which has been made, with the exception of filling in and leveling off the areas between the different yards, has been done by company men and work trains, without the use of other earth-handling machinery or tools than those in ordinary daily service.

Two-thirds of this work, approximating a total of 1,000,000 cu.yd., is in embankment, about one-half of which was secured from excavation for tracks, buildings and bridges. The balance of fill has been furnished in cars from ashpits and culm banks in the vicinity, or from commercial dirt shipped from points along the line to be disposed of by the company.

FIG. 3. PANORAMIC VIEW NEAR CENTER OF YARDS, SHOWING COAL DOCK, WATER TANKS, POWER HOUSE, ROUNDHOUSE AND OFFICE BUILDING, NOV. 10, 1912

BRIDGES

The development of this yard has included the abandonment of three grade crossings which have been replaced with two overhead structures, one at St. Clair and one at Dormers, near Mill Creek.

Russell St. bridge, which eliminates Patterson St. and Second St. crossings, in St. Clair, spans five tracks and is a lattice-steel superstructure, clear span 89 ft., 22 ft. overhead clearance, on concrete abutments, with approaches on the east from the Pottsville road, and on the west to Patterson and Second Sts.

At Dormers, a lattice-steel superstructure with three spans of 99 ft. each and spanning 20 tracks, rests upon two concrete abutments and two concrete piers, has standard overhead clearance, and the approach thereto on the east crosses Mill Creek by a single concrete arch of 44-ft. span.

South of the yards at Mill Creek Junction, two concrete-arch bridges, having three 29-ft. spans each, one for double and one for single track, cross the Schuylkill River and connect with the Mount Carbon & Port Carbon & Schuylkill Valley railroads, respectively, thus forming a Y, by which trains may enter or leave the yard in either direction without back-up movement.

DRAINAGE

As the floor of the valley is very flat, Mill Creek, which is its natural drain, has not been entirely adequate, and when construction was started the lands of the entire valley were very swampy. To correct this, an open drainage canal, 10 ft. wide and 5 ft. deep, was dug parallel with and along the public road west of the yard from the lower end of the south-bound receiving tracks to a point near Dormers bridge, a distance of 6000 ft. At

this place it connects with a 4x10-ft. concrete box culvert, 800 ft. long, crossing under twenty tracks and discharging into Mill Creek at a point nearly opposite the middle of the north-bound receiving yard. This supplemental drain not only receives and disposes of surface flow from the western watershed, but has fully accomplished the successful drainage of the saturated lands.

Running longitudinally through the center of the yard from the upper ashpit to a point of discharge into Mill Creek, opposite the engine house, a terra-cotta sewer, with manholes at 250-ft. intervals, connects with lateral pipes carrying the storm and other waters from buildings, coal dock, ashpits and water columns. The diameter of this trunk-line sewer increases gradually from 12 in. at its beginning to 18 in. at the coal dock and 24 in. at its junction with the manholed drains from the engine and power houses, from which two 30-in. pipes, laid in concrete, carry the full volume of drainage under several tracks to the creek.

The sewage from the office and storehouse buildings passes through septic tanks and filter beds before reaching the main sewer and creek.

Water Supply

From the 12-in. main of the Silver Creek Water Co., which parallels the yard on the west, water is furnished at 250-lb. pressure through four 8-in. service pipes. One of these with a branch line of the same diameter feeds the engine and power houses; three others supply four 50,000-gal. tanks of standard construction located in different portions of the yard; and, from them, the water flows through taps and pipes of varying diameters to water columns, ashpits, coaling station, shops, storehouse and the office buildings.

Valve houses of concrete and timber, over the 8-in. lines, contain and protect the necessary meters, pressure reducers, bypasses, valves, etc. A supplementary supply for cooling hot ashes is secured from a natural reservoir west of the scale office, is delivered to the ashpits by gravity through an 8-in. terra-cotta main, and is augmented by water pumped from a well east of the engine house, into which the drop-pit drainage flows.

Buildings and Structures

In the open space within the loop track and midway between the north- and south-bound yards are the engine-house and storehouse buildings; and, in the triangular area immediately north of these, reaching to the center of the classification yard, in consecutive order, are the sites of the power house, mechanical ashpits, coaling station, and ashpit for mountain and yard engines.

Engine House—The engine house, in service since the fall of 1912, is a circular structure, the roof slabs, girders, beams and supporting columns of which are reinforced concrete upon concrete masonry foundations. The wall panels between columns, where not occupied by the large windows and glazed doors, are filled in with red brick, and all trim is painted standard Philadelphia & Reading colors.

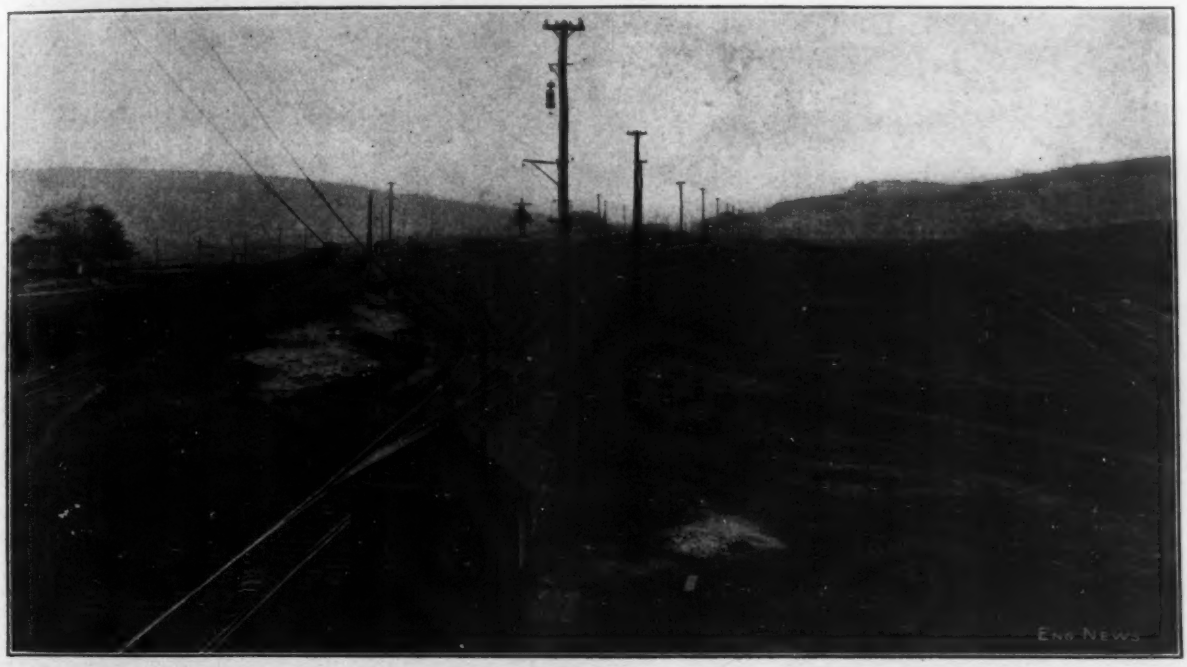


Fig. 4. North End of South-Bound Classification Yard

The outer and inner radii of the building are 198 ft. 4⅛ in. and 107 ft. 8½ in., respectively. There are 52 bays, of which 33 are provided with engine pits, three are taken up by passageways and 16 are used for a machine shop; the last, however, are so designed that additional pits may be built therein if required.

The engine pits, with walls and concave floors of concrete are 65 ft. in length; they are capped with creosoted yellow-pine stringers tie-plated for the rails, and the total length of stalls is 90 ft.

About one-half the central area surrounded by the house is occupied by an 85-ft. deck-girder turntable operated by electric tractor, the power for which is trans-

mitted through the pivot. The center stone, floor and walls of turntable pit are also of concrete with 8x12-in. oak coping. Drainage from the areas of the inner roof and pits is discharged into the turntable pit through an 8-in. pipe in each bay and is in turn carried to the general system by a 24-in. terra-cotta main.

Above and below the roof, over each of the 33 pits and over one entrance bay, are 34 smoke-jacks and hoods; 17 are of reinforced concrete (Figs. 7 and 8) and 17 are

ters and shafts to the machine shop and engine [illegible] for the warming of the building and locomotives, respectively. This duct also accommodates water, steam and compressed-air pipe lines. Hydrant boxes containing 3-in. water and 1½-in. air and steam lines are [illegible] in alternate spaces between the stalls.

Two extensions occupying one bay each, and a third passing through three bays, of reinforced-concrete and brick construction similar to that of the main building,

FIG. 5. REINFORCED-CONCRETE ROUNDHOUSE UNDER CONSTRUCTION, JULY 16, 1912

FIG. 6. TURNTABLE PIT IN CENTER OF ROUNDHOUSE

of cast iron. The floors between the engine pits and in the machine shop are of creosoted long-leaf yellow-pine blocks on 4-in. concrete foundations and 1-in. sand cushions. Ceiling and walls of machine shop are whitewashed and wainscoted in black.

Inside the building, beneath the floor, adjacent to the outer wall and for its entire circumference, there is an air and pipe duct 7½ ft. wide and 4 ft. 8 in. high, through which air for the heating of the house and engines is driven and from which it passes through registers and with widths of 24 ft., are located at intervals outside the house.

These are for the accommodation of the electric motors, radiators and fans by which air is heated and driven through the duct and into the building. In the larger of these fan houses are offices, neatly finished in yellow pine, for the roundhouse foreman and his staff.

Another extension of the building, similar to the fan houses and projecting through four bays, has been constructed to contain the boiler-wash system. This in-

cludes three iron tanks for water storage, which are placed in concrete pits under the floor of the boiler-wash room; they receive the blow-down water from locomotives through suitably arranged pipe lines and steam separating tanks, the vapor from which serves to heat the boiler-filling water. The water used for washing, after having been clarified through filters, is returned to the tanks and the process repeated. The plant includes two

FIG. 7. INTERIOR OF ROUNDHOUSE, SHOWING REINFORCED-CONCRETE SMOKE JACKS

motor-driven centrifugal pumps for washing and filling and one pump for boiler testing.

Two concrete drop pits, intersecting eight engine pits have been provided for lowering engine and tender wheels, by means of specially designed screw jacks operated by induction motor and friction clutch. The wheels, lowered by these jacks to trucks running on narrow-gage tracks in the lower pits, may be pushed from one engine pit to another, lifted and run off as desired. All shop machinery is electric driven.

OIL HOUSE AND WAREHOUSE—This building, in which are toilet conveniences for the motive-power department employees, has been constructed immediately south of the engine house along and west of the track leading thereto from the lower end of the yard. This is a one-story building, 35x135 ft., of brick, concrete and steel fireproof construction, and is divided into four compartments for toilets, washstands and lockers, oil serving and waste storage. A 35x40-ft. brick and steel-frame extension has been provided for barrel storage.

The oils are to be stored in tanks in the basement of the serving room, to which they will be delivered by the storage system. This basement projects under a 12-ft. platform extending along the track side of the building for two-thirds of its length. The platform, all floors and roof slabs are reinforced concrete; the steel trusses over the oil rooms are also incased in this material. The building is about completed and will probably be ready for occupancy within the next month.

Between the Y branches at Mill Creek Junction and facing the tracks of the Mount Carbon and Port Carbon railroad is a two-story interlocking tower 38 ft. 9 in. long and 38 ft. 6 in. wide, of standard construction. Its foundations, cellar walls and floor are concrete; the first or lower floor is of brick, with interior of walls whitewashed above a dark-painted wainscot; the second floor or lever room is timber and glass construction with inside finish in natural yellow pine tinted and varnished. The building is about finished and contractors for interlocking have started upon the installation of the 60-lever electro-mechanical machine by which the switches, derails, locks and signals controlling the tracks of the adjacent yard and junctions will be operated. At the upper end of the classification yard, and possibly at one or more of the other yard throats, later installations of additional mechanical or electric interlocking systems are contemplated.

A frame building, located in the south-bound departure yard a short distance below Dormers bridge, the foundation walls and floors of which are concrete, having a length of 75 ft. and a width of 24 ft., provides quarters and storerooms for car and air inspectors.

OFFICE BUILDING—A short distance southwest of the engine house there is a three-story office building, 65x 41 ft., with structural-steel frame, red brick walls and asbestos slate roof, on walls of stone masonry with concrete cellar floors. The first floor is occupied by offices for assistant train-master, master mechanic, train de-

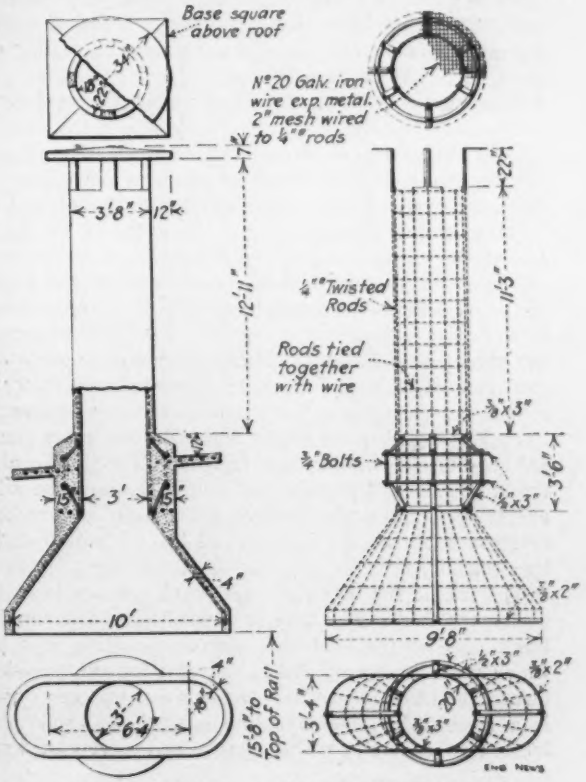


FIG. 8. DETAILS OF REINFORCED-CONCRETE SMOKE JACKS

spatcher, clerks and conductors, and in addition there are linen closets, telephone-exchange room and adequate toilet accessories. The second story is taken up with pleasant game, reading and lunch rooms, a fully equipped kitchen and toilets. The third floor is devoted to dormitories, locker rooms, shower baths and toilets. The building is plastered throughout, trimmed and wainscoted in chestnut, heated by hot water, and affords not only adequate office facilities, but comfortable quarters for through crews required to lay over night at St. Clair.

At the upper end of the classification yard there is a two-story scale office of red brick, 47x43 ft., on stone masonry walls, with concrete cellar floor, asbestos slate roof, and hot-water heat. Within this building are offices for the yard-master, weigh-master, shipping clerks, and for the operating device of the track scale. The scale, of P. & R. standard form and manufacture, on concrete foundations, and drained by the office-building sewer, is 60 ft. long and is equipped with a dead track.

The plumbing, painting and finish of this building are of the same standard character as those in the other office building; there are stationary washstands in each of the rooms, adequate toilets, and the floors of both structures have been treated with creosote oil. This building has been completed and occupied for nearly two years.

COALING STATION—Between the south-bound classification and north-bound yards, an elevated coaling station 200 ft. long has been erected, the bunkers, building and roof of which are wooden construction. The coal dock proper has two tracks from an approach track 950 ft. long, all carried on iron girders crossing 52 concrete piers. The coal bunkers have a capacity of 1200 tons. There are 16 of them, and they are provided with the same number of chutes on each side for coaling engines on two tracks.

The spaces between the piers under the coal dock, which are inclosed for one-half its length, have concrete floors and provide six bins for the storage of sand and two for the accommodation of the drying apparatus. From the drying rooms, sand is driven by compressed air to bins in the upper structure, from which it is fed directly by chutes into the sand boxes of locomotives.

The ashpit generally used by road engines, and known as the mechanical ashpit, is located on the running track between the coaling station and the south-bound departure yard. It is 175 ft. in length, of brick, concrete and steel construction, and has two depressed pits in which are narrow-gage tracks for small cars which receive the hot ashes as they are dumped from the two upper standard-gage tracks running over the pits. The third central track, of standard gage, is for cars into which the ashes are tripped from the steel buckets, from an overhead crane movable in the direction of the pit and operated by electricity.

The ashpit for mountain and yard engines is of the customary trestle type and is located upon the running track east of the coal-dock approach. Over this pit, which has a length of 192 ft. between its concrete abutments, the track from which the engines drop their ashes is a steel-girder superstructure carried on brick piers incased in concrete, with concrete and steel foot walks on either side.

The hot ashes are received on a brick platform from which, after having been cooled, they are loaded into cars on a depressed track parallel with and east of the platform. At both ashpits the tracks are open at either end that engines may leave in the order of their arrival, and the arrangement is such that they may take water, sand and coal, and deposit ashes, in convenient rotation, on their way to and from the engine house.

At the site of the proposed car-repair shops, between the north-bound departure and north-bound main tracks, opposite the coal dock, three buildings are contemplated for heavy, intermediate and light repairs.

SHOPS—Contract has been let and work started upon the heavy and intermediate shops, the dimensions of which are 600x84 ft. and 460x53 ft., respectively; the size, construction, finish and equipment of the light-repair shop proposed later will not differ materially in the same features from these two buildings, which are of uniform type.

The concrete masonry carrying the steel-skeleton building frames and brick walls extends 5 ft. 9 in. above the graded ground surface to bottom of window frames, and is covered with a projecting coping, all exposed surfaces of concrete having granolithic finish. Roof slabs, heat ducts, floor foundations, sills, lintels and track walls are also of concrete.

The very small wall areas above and between the steel window frames and rolling doors are filled in with red brick. Floors are of yellow-pine plank on concrete base. All movable window sash and ventilators are mechanically operated.

Two fan-house extensions at each of the larger buildings—with fans, radiators and motors, in connection with fans inside the intermediate shop, wall registers and ducts under the floors of the three buildings, complete a heating system identical with that at the engine house.

Four tracks, on yellow-pine stringers spaced 18-ft. centers are carried on concrete walls through each of the large buildings. The floor surface on the intermediate shops is to be free from tracks and the building is divided into smith, machine, paint and woodworking shops, oil and storerooms and offices.

In addition to the usual machinery and tools in each building, two 15-ton overhead traveling cranes in the light-repair shops, two similar cranes of 40 tons and 15 tons capacities in the heavy-repair shops and two 15-ton cranes between the buildings, all operated by electric current from the power house, complete the shop equipment. Details of interior and exterior finish, lighting, painting, etc., are to be of the same character and standard as at the other buildings. The concrete foundations, coping and window settings have been built in offsets that the roof and floor lines of the buildings may coincide with the 0.5% profile of the tracks running through them.

From St. Clair to Dormers, between Mill Creek and the public road, and not well adapted to yard extension, is an admirable site for homes, on which the railway company contemplates the early erection of cottage dwellings, with gardens, for yard employees.

POWER HOUSE—The power house, located 145 ft. north of the engine house, is a brick and steel structure, 127x 95 ft., on concrete foundations, connected with which, along its western wall, are concrete coal pockets and pier approaches carrying a steel-girder track superstructure. The building is equally divided into boiler and engine rooms by a brick partition or fire wall reaching from the lower floors to the roof; the boiler apartment occupies the entire space above the floor of the adjoining engine-room basement, into which it opens.

In this basement are the foundations for engine and electric equipment, busbar and oil-switch apartments inclosed by barrier doors and ample space for storage. A brick high-tension distributing tower adjoins the building on the east, the upper division of which accommodates the necessary arresters, disconnecting switches and choke coils; in its basement are the transformers, etc.

The slag-covered roof slabs, floors and busbar devices

are reinforced concrete. The ceilings and interior walls are all whitewashed above a painted black wainscoting. The house is well lighted from two arcs in the engine room and tungsten globes; and windows and transoms are mechanically closed or opened. A brick-lined steel stack 150 ft. high, on a 40-ft. concrete base, occupies a site at the south end of the building, and an underground concrete tunnel 6 ft. high and 3 ft. wide, connecting the power and engine houses, accommodates the steam and air lines, with allowance for working space around their pipes.

Light, Heat and Power

The boiler-house equipment consists of four 300-hp. vertical water-tube boilers with economizers, arranged in batteries of two each with alleyway between sets. Room for four additional boilers has been provided for future extension. The boilers are hand-fired from wagons, on a narrow-gage track parallel with and in front of the fires, into which coal is delivered by gravity through gates and chutes in the western wall of the building and from the outside coal-dock bunkers. Shaking grates have been installed for the burning of fine anthracite coal.

Draft is secured through the breechings of a brick flue above and in front of the boilers and which is connected with the stack. Forced draft when required is obtained from a double-inlet multivane-fan blower, direct connected to a vertical self-oiling engine, through a duct and gates located under the floor and in front of the boilers.

A steam header arranged in double-loop system has its boiler outlets so controlled by automatic check- and stop-valves as to properly regulate the steam supply under all conditions requiring the cutting out of one or more boilers.

The boilers are fed by two 14x8x12-in. outside-packed plunger pumps arranged in duplicate, through an 1800-hp. open-type feed-water heater, into which return water from the engine-house heating system is discharged by a vacuum pump provided for the purpose.

Ashes are scraped by hand into buckets in a pit beneath and in front of the boilers; these loaded buckets are transferred by chain hoist and overhead trolley to a pneumatic lift at the southeast corner of the house, by which they are raised over and emptied into cars on the outside coal-wharf track, dumping being controlled from the boiler room.

In the engine room are two compound steam-driven two-stage air compressors, each having a capacity of 1700 cu.ft. of free air per minute, delivering air at 120 lb. per sq.in. They have Corliss valve gears and automatic oiling features throughout.

Compressed air is delivered to two large storage reservoirs located outside of the building, these being fitted with outside cooling pipes, through which air must pass when delivered from compressors before entering reservoirs. As a further means of insuring cool dry air, these aftercoolers are arranged in tandem, so that the air passes through a double cooling system before entering shop or yard piping.

The main power-generating equipment consists of two horizontal cross-compound automatic-cut-off 600-hp. engines, direct connected to three-phase 3300-volt 25-cycle alternating-current generators. Direct current for exciting alternators and for supplying power-house lighting, is provided for by means of one 90-hp. horizontal side-crank engine, direct connected to a 50-kw. 125-volt generator, and one 50-kw. motor-driven generator set.

Two 40-kv.a. 2200-volt three-phase 60-cycle frequency-changing sets, operated by 440-volt induction motors, and necessary transformers have been provided expressly for the office lighting system. There are three 50-light 6.6-amp. mercury-arc rectifier sets and panels for the arc lamps in the yards. One 15-panel remote-control switchboard serves for the engine room. There is also an overhead traveling hand-power crane of 12½ tons capacity.

Additional installation is to be made, of a 100-kw. 750-r.p.m. 550/275-volt commutating-pole direct-current compound-wound three-wire generator, coupled to a 150-hp. 3300-volt three-phase 25-cycle four-pole, self-starting rotating-field synchronous motor, with two control panels, to furnish direct current for the car shop, crane service, and variable-speed tool drive.

The power plant at St. Clair is intended to supply current for all classes of service, including arc and incandescent lighting for yard, engine house, offices and depot, as well as for engine-house and car-shop machinery, cranes, etc. The 3300-volt 25-cycle three-phase high-tension service has been adopted with a view of its possible extension for the electrification of the 3% grade between St. Clair and Frackville, and to other outlying points. All power circuits are 440-volt three-phase 25-cycle lines, except the direct-current circuits for the car-shop, the cranes, and the variable-speed machinery, which are to carry 550 and 275 volts. All alternating-current circuits to engine house, boiler wash-system pumps, heating fans, turntable, wheel jacks, and shop machinery, are operated from three 75-kv.a. 3300/440-volt transformers mounted on concrete foundations outside of the engine house.

The lighting installation has received particular attention, with the result that the layout of lamps as installed provides one of the most satisfactory yard-lighting systems to be found. There are to be 150 metallic-flame 6.6-amp. arc lamps, 82 of which are now in use. These are suspended on mast arms 30 ft. high, spaced 400 ft. apart, in the wide track spacings already referred to. A well balanced illumination has been secured by the alternation of lamps in the adjacent aisles. Sectionalizing-pole switches, in the arc circuits, permit the cutting out of sections in case of line trouble, insuring prompt location of any disturbance, and the maintenance of service with the least amount of outages.

The engine house is lighted by 60- and 100-watt tungsten lamps, with enameled-steel reflectors, mounted 12 ft. high and operated on 25-cycle 220/110-volt three-wire systems. Portable carbon lamps on 60-cycle circuits have been provided, and may be used by plugging into the various boxes located throughout the engine house, as well as in the heating duct under the floor of the engine house.

The general machine-shop illumination is obtained by 250- and 440-watt tungsten lamps, in addition to which small 8-cp. carbon lamps have been provided, connected with the conduit system under the floor, and installed at the different machines for individual lighting. All wiring is arranged in sheradized (galvanized) conduit with mains installed in wood box trunking for preventing deterioration by sulphur fumes, etc. The office illumina-

tion is from tungsten lamps operated on a 2200/220/110-volt three-wire 60-cycle circuit. The car-shop will have series metallic-arc lamps, supplemented by tungsten incandescents on a 25-cycle 220/110-volt three-wire circuit.

In developing the design and installation of the electrical and mechanical features of this plant, the Motive Power Department aimed to secure the greatest simplicity and continuity of service under all conditions. With this object in view, all high-tension switches and busbars have been inclosed in concrete fireproof cell compartments, with barrier doors closing all openings. Conduits carry all high-tension varnished cambric cables from generators to cell compartments and to the high-tension distributing tower. Transformers for operating frequency-changing sets are mounted in the basement of the distributing tower, and above, on a level with the engine-room floor, are the necessary choke coils, lightning arresters and disconnecting switches. An outlet canopy is provided for the protection of lines which connect to an H-frame for distributing the high-tension current for depot and yard lighting. Space for future growth, both for steam power and electrical generation, has been provided, and the installation, taken as a whole, provides a very reliable and flexible service.

Old Yards and Shops

At Palo Alto, about a mile southwest of Port Carbon, are the engine-terminal and car-repair buildings which will be replaced by those above described. Adjacent to them, and northward to Mill Creek Junction, lie the yard tracks used for the reception and departure of main-line trains under the system of operation effective before the new St. Clair yards had been put in service.

Until that time, the old yard at St. Clair had been devoted exclusively to the weighing and classification of coal, the making up of "mountain" trains and minor repairs to cars.

Under the older methods, main-line trains of empty cars, north bound, were broken up at Palo Alto, and taken in light drafts by drag engines to St. Clair, after the shop cars had been separated from those in condition for distribution. Comparatively short trips of loaded cars, after having been weighed and classified at St. Clair, were also taken by drag engines to Palo Alto and there grouped in trains for main-line movement south. All the heavy repairs to cars in both directions were made at the Palo Alto shops.

Under the new conditions, the maintenance of practically two yards or terminals has been abolished, all movements and repairs have been concentrated at one point, the short-line crews plying between St. Clair and Palo Alto are no longer necessary, and the engine-terminal structures at Palo Alto have already been demolished.

The elimination of the old car-repair shops will probably follow the completion of the new St. Clair plant and the railway company, in addition to the other advantages consequent upon the new construction, will thus have released to it a yard covering an area 1½ miles long by 400 ft. wide, with a trackage of ten miles, which will doubtless prove a valuable asset for overflow, storage or other purposes.

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Professional Foresters in Germany number nearly six thousand, counting only those associated with various technical societies.—Forest Notes, U. S. Forest Service.

Rules Governing the Submission of Sewerage and Water-Supply Plans to the New Jersey State Board of Health

Under statutes of the New Jersey Legislature passed in 1900 it is unlawful to build any new sewer, sewerage or sewage-disposal system or to construct or operate any plant to purify water for "potable use" unless plans for the same have been approved by the State Board of Health. After experiencing much inconvenience through lack of uniformity in the size of the plans and mode of presenting other data and after being handicapped in various ways by the incompleteness of the data submitted with the plans the Board, on June 23, 1913, adopted rules and regulations regarding the submission of plans and reports for the purposes stated. The rules were prepared by C. G. Wigley, engineer of the Board, under the supervision of R. B. Fitz-Randolph, chief of the Division of Food, Drugs, Water and Sewerage. Before their adoption they were submitted to a number of engineers for comment. The many seashore cities in New Jersey led to the adoption of lower minimum grades than would otherwise have been allowed. We reprint the rules for sewerage and sewage disposal in full and such parts of the rules for water-supply and water-purification systems as are not duplicates of the other rules:

RULES FOR SEWERAGE AND SEWAGE-DISPOSAL SYSTEMS

SUBMISSION OF PLANS

1. Plans shall be submitted to the Board for examination, at least two weeks prior to the date upon which action by the Board is desired. From this it is not to be inferred that action by the Board will always be taken within the time mentioned.

INFORMATION REQUIRED

2. The plans for a complete sewerage and sewage-disposal system shall include the following:

A general map of the municipality or sewerage district.

Profiles of all sewers proposed.

Details of construction of manholes, flush tanks, and special structures pertaining to the sewers.

General and detailed plans for disposal works.

A comprehensive report upon the proposed system by the designing or consulting engineer. This report to be typewritten upon letter-size paper, and the sheets firmly bound together.

A preliminary report, containing data and information sufficient for the complete understanding of the project may be submitted to the State Board of Health for their consideration, prior to the submission of detailed plans.

MAP OR GENERAL PLAN

3. (a) The general plan referred to in paragraph (2) shall be drawn to a scale not greater than 100 nor less than 300 ft. to 1 in., and shall show the entire area of the municipality or district. If the municipality is greater than two (2) miles in length the map may be divided into sections, conforming in size to those mentioned in Sec. 7 of these rules. The sheets shall be bound together and a small index map supplied, showing by number the area covered by the various sheets. A general plan shall accompany each application, in the case of a new sewer system or any extension or modification of any existing sewer system unless such general plan has already been submitted.

DETAILS OF MAP—(b) This plan shall show all existing or proposed streets, the surface elevations at all street intersections, and contour lines at intervals of not more than 10 ft.

If it is intended to defer the construction of sewers in some of the streets, the plan shall show that sewerage facilities are provided for all such sections of the municipality or sewerage district. The plans shall also clearly show the location of all existing sewers, either "separate" or "combined," the location of the disposal works, and the location of existing and proposed sewer outlets or overflows. The true or magnetic meridian, the town or borough lines, title, date, scale, direction of flow and average water elevation of

the stream shall also be clearly shown. The elevation of the highest known freshets at the outlets and site of the disposal plant shall be given. Any area from which sewage is to be pumped shall be shown by light shading, coloring or other distinctive marks.

LETTERING, LINES AND SYMBOLS—(c) Letters and figures shall be clearly and distinctly made. Sewers to be built at present shall be shown by solid lines, and sewers to be constructed later shall be shown by a line of dashes, as - - - - - - - Existing sanitary sewers shall be shown by the following symbol, ..., and combined sewers by a dot and dash, .—.—. All topographical symbols used are to be the same as those of the United States Geological Survey.

ELEVATIONS—(d) Elevations of the surface of the streets should be placed outside the street lines in the upper right angle, or opposite their respective positions in the street. The elevations of sewer inverts should be shown at street intersections, ends of line, and wherever a change of grade occurs. The elevations of the sewer shall be written close to the point to which they refer, parallel with the sewer line and between the street lines. The elevations of surface shall be shown to the nearest 0.1 ft.; those of the sewer invert to the nearest 0.01 ft. The sizes and gradients of all proposed and existing sewers shall be marked along the line of the sewer.

SEWER APPURTENANCES—(e) All sewer appurtenances and unusual features, such as manholes, lampholes, flush tanks, siphons, pumps, etc., shall be designated on the plans by suitable symbols and referenced by a legend near the title.

PROFILES—4. Profiles of all sewers over 8 in. in diameter and of all 8-in. sewers, where gradients less than that given below are used, shall accompany the application. Profiles of all sewers must be approved before they are constructed.

Profiles of sewer lines shall be prepared and drawn to such a scale as to clearly show the structural features of the sewer. For ordinary use, the following scales are suggested: Vertically, 10 ft. to 1 in.; horizontally, 100 ft. to 1 in. Both scales must be clearly shown upon each sheet. Upon these profiles shall be shown all manholes, flush tanks, lampholes, siphons, and stream crossings, with elevations of stream bed and normal water. Figures showing the sizes and gradients of sewers, surface elevations, sewer inverts, etc., should be shown with the same frequency as required for the map.

GRADES, ETC.—The following gradients for sewers flowing half full are suggested as minimum grades for ordinary use, as with careful construction a theoretical velocity of approximately 2 ft. per sec. can be obtained:

Size of pipe, in.	Fall in ft. per 100 ft.
8	0.40
10	0.29
12	0.22
15	0.16
18	0.12
20	0.10
24	0.08

The sewers should have a capacity when flowing half full sufficient to carry twice the future average flow twenty-five years hence, plus a sufficient allowance for ground water infiltration.

When grades lower than those given are used, an explanation and reasons for the use of such grades should be included in the engineer's report. On each sheet of profiles must be given, under the title, an index of the streets appearing on that sheet. Profile sheets shall be numbered consecutively.

DETAIL PLANS—5. Detail drawings of sewer sections except where terra cotta or iron pipe is used, and of all sewer appurtenances, such as manholes, lampholes, flush tanks, inspection chambers, siphons and any special structures, shall accompany the general sewer plans.

The detail plans shall be drawn to such a scale as to show suitably and clearly the nature of the design and all details, such as manhole frames and covers, iron pipes, valves, gates, etc.

DISPOSAL WORKS—6. The plans for the disposal works shall include a general plan upon which reserve areas or future extensions are clearly shown, and detail plans of the various units and structures which comprise the plant.

A weir or other measuring device shall be provided at some convenient point, and the installation of a recording device is recommended, and in particular instances may be required.

DETAIL PLANS—The detail plans shall show longitudinal and transverse sections sufficient to explain the construction of each unit. They should also show the distributing and drainage systems, general arrangement of any automatic devices, sizes of stone, gravel, or sand used as filtering material, and such other information as is required for the intelligent understanding of the plans.

DRAWINGS—7. All drawings submitted shall be neatly and plainly executed and may be traced directly on tracing cloth, printed on transparent cloth, or printed on any of the various papers which give distinct lines. All prints shall be clear and legible.

SIZE OF DRAWINGS—With the exception of the map, the following dimensions are suggested for ordinary use: Distance from top to bottom, 20 or 30 in.; length, 24 in., 32 in., 40 in. or 48 in., or thereabouts. By this section it is intended to prevent the use of long profiles and unnecessarily large maps, which are difficult to file or to use.

TITLE—Each drawing shall have legibly printed thereon the name of the town or persons for whom the drawing is made, the name of the engineer in charge, the date, the scale, and such references in the title as are necessary for the complete understanding of each drawing.

ENGINEER'S REPORT—8. A report, written by the designing or consulting engineer, should accompany all plans for complete sewerage systems, and shall give all data upon which the design is based, such as:

INFORMATION CONCERNING SEWER SYSTEMS—(a) The nature and extent of the area which it is proposed to include within the present system of sewerage, and of the area which it is planned shall ultimately drain into this system.

(b) The population to be served, both present and estimated for twenty-five years hence.

(c) The estimated per capita daily flow of sewage to be cared for.

(d) The total and per capita water consumption of the town at the present time.

(e) The allowance made for leakage into the sewers.

(f) The estimated daily flow of sewage, including leakage.

(g) The character of the sewage (whether domestic or including manufacturing wastes, and in case of the latter, the nature and approximate quantity of the same stated in specific terms).

(h) Method of flushing or periodically cleaning the sewers.

(i) That portion of the sewers to be built at the present time.

(j) The minimum grades of sewers for each size used.

(k) If there are sections which cannot drain into this system, the extent of such sections and the probable future disposition of the sewage from these sections.

(l) Distance of sewer outlet from shore and depth of water at mean tide at outlet, if outfall discharges into ocean or large stream.

A list of bench marks or fixed elevations should be included in this report.

INFORMATION CONCERNING DISPOSAL PLANT—With regard to the disposal plant, the engineer's report shall cover the following subjects:

(a) The method of disposal to be adopted and a description of the units of the system.

(b) The rate of working of each unit.

(c) If disinfection is to be used, the name of the disinfecting substance, the quantity per million gallons of sewage and the method of application.

(d) The nature of the body of water into which the effluent discharges, with particular reference to the run-off during dry weather.

(e) The disposal of sludge.

(f) All conditions peculiarly characteristic of the locality and which in any way affect the design of the system.

(g) Special devices used in connection with the disposal system.

(h) Special methods of maintenance or operation of the system.

(i) The results expected from the purification system.

(j) Explain any provisions for reserve units in pumping plants, pipe lines, filters, etc.

SPECIFICATIONS AND ESTIMATE OF COST

9. Specifications for the construction of the system of sewers and sewage disposal works and an estimate of the cost of the same shall accompany all plans for new or original systems. With plans for extensions of existing systems, specifications may be omitted, provided that these extensions are to be constructed in accordance with specifications filed previously with original plans.

EXTENSIONS OF PRESENT SYSTEMS—10. If the plans are solely for the extensions of an existing system, then only such information as is necessary for the comprehension of the plans will be required. This information must in general conform to the above requirements for a complete system.

GENERAL REQUIREMENTS. APPLICATION FOR APPROVAL

11. The application for approval of plans shall be made by the proper municipal authorities, persons for whom the work is to be done, or their properly authorized agents, upon blank forms which will be supplied by the Board.

SYSTEMS ON SEPARATE PLAN—Under ordinary circumstances the Board will approve such plans only when designed upon the separate plan, in which all rain water from roofs, streets and other areas and all ground water, other than unavoidable leakage, is to be excluded.

BYPASSES—No bypasses which may allow raw or partly purified sewage to be discharged from the sewers or disposal works shall be included in the plans, except by special permission of the Board.

DEVIATION FROM APPROVED PLANS—NO DEVIATION FROM APPROVED PLANS SHALL BE MADE, unless amended plans, showing such proposed changes, have been submitted to and approved by the Board.

RULES FOR WATER-SUPPLY AND WATER-PURIFICATION SYSTEMS*

SUBMISSION OF PLANS. 1. [Same]

INFORMATION REQUIRED. 2. [Same except]

Detailed drawings showing construction of any special structures in the distribution system.

GENERAL PLAN. 3. [Same except]

* * * covering the entire area of the municipality or district to be supplied with water, and shall accompany each application in the case of a new water system, or any extension or modification of any water-supply or water-purification system, unless such a general plan of the entire area has been previously submitted.

DETAILS OF MAP—(b) This map shall show all existing or proposed streets, the surface elevations of all street intersections, and the elevations of the principal parts of the water system, such as water at the intake, in the reservoir or standpipe, etc. The map should show that water-supply facilities can be provided for all sections of the municipality or district, even though the construction of pipe lines in some of the streets is to be indefinitely deferred. The location of intakes, valves, hydrants, reservoirs, pumps, standpipes and purification plant, and any special structures, shall be shown and referenced in a legend near the title. The size of pipes shall be written between the street lines and along the pipe. The map shall also show the true or magnetic meridian, title, scale, date, the municipal or district boundaries, the mean, low and high water elevations of water at the intake. If the site of the pumping plant is subject to flooding, the elevation of the highest known flood water must be given.

LETTERING, LINES AND SYMBOLS. [Same]

ELEVATIONS. [Same for first 4 lines; rest omitted]

DETAIL DRAWINGS—(e) Detail drawings of all special appurtenances, such as blow-offs, siphons, intakes, conduits, reservoirs, collecting galleries, filters, etc., shall be submitted.

(f) Profiles of long conduits or pipe lines may be plotted to a convenient scale and shown on sheets of the sizes mentioned below.

PURIFICATION WORKS. GENERAL PLANS. 4. [About the same]

DRAWINGS. 5. [About the same]

ENGINEER'S REPORT

6. A report, written by the designing or consulting engineer, shall be presented with all plans for complete systems, and shall give all data upon which the design is based or which is required for the complete understanding of the plans.

Where a purification or treatment plant is to be constructed, a measuring device shall be provided at some convenient point, and the installation of a recording device is recommended, and in particular instances may be required.

SOURCE OF SUPPLY—If no purification process is provided, the nature and extent of the watershed, with special reference to its sanitary condition, shall be fully and explicitly discussed, together with proposed methods and regulations for the prevention of accidental or other pollutions.

MAP OF WATERSHED—A small scale map of the watershed, showing the roads and the number and character of buildings, shall be included in the report. Other features which should be discussed in the report are: Storage capacity, average depth, general nature and area of the storage reservoir, liability of odors or tastes in supply, and removal of color, iron, or hardness.

WELLS AND COLLECTING GALLERIES—If the water-supply is to be taken from wells, describe the number, depth, size and construction of the same; method of pumping, capacity of pumps, kind of strainer used, nature of ground through which wells will be driven, and probable flow of the wells. If collecting galleries are to be used, describe their construction.

INFORMATION CONCERNING PURIFICATION PLANT—The following information is required respecting the purification plant: The method of purification and a description of the units of the system; the rate of operation of each of the systems; the rate of operation of each unit of the plant; if any chemicals are used, the nature and quantity of each with a description of the appliances for adding the same to the water; a description of all conditions peculiarly characteristic of the water or locality which in any manner affect the design or operation of the system; a description of all special appliances used, any special methods of maintenance or operation of the plant, and the extent of purification expected or guaranteed.

If for purposes of fire protection it is necessary to provide bypasses, by which partly treated or raw water can be turned into the mains, they shall have valves upon them of such a character that they may be properly sealed by the State Board of Health. These valves shall not be opened except in accordance with the provisions of Chap. 317, Laws of 1912.

The report should further include a description of the nature and extent of the area to which it is proposed to supply water, or which will ultimately be supplied from the system, the quantity of water to be supplied daily, and the population to be served, the portion of the system to be constructed at present and the minimum depth of pipe below the surface of the ground. A description of any provision for future units of pumping plants, filters, etc., should be given.

UNSUPPLIED DISTRICTS—Should there be areas in the municipality or district which, on account of topography or for other reasons cannot be supplied with water, a definite statement to this effect must be made and the probable future supply of this omitted territory should be discussed.

SPECIFICATIONS. 7. [Same]

EXTENSIONS OF PRESENT SYSTEMS. 8. [Same]

GENERAL REQUIREMENTS. APPLICATION FOR APPROVAL. 9. [Same]

DEVIATION FROM APPROVED PLANS. [Same]

SAMPLES OF WATER TO BE ANALYZED—The Board will collect and analyze samples from all public water-supplies at regular intervals as required by law. Requests for the analysis of special samples should be made to the Board in writing, as samples will not ordinarily be examined unless collected by representatives of the Board.

*Parts substantially the same as already given for sewerage and sewage disposal are not repeated here but are thus indicated: [Same]

Motor Omnibus Accidents in London, England

By H. Raynor Wilson*

So many deaths from being knocked down and run over by motor omnibuses and other power-driven vehicles occurred in London, that the British Parliament appointed in November last a committee to investigate the matter and to make recommendations as to measures to be taken to secure greater safety in the streets. This committee has just reported.

In 1904 the average number of journeys per head taken by the inhabitants of London was 150; now it is 228 per head. During the year 1911 there were in London 821,819,741 tramway (street car) passengers, 400,628,487 omnibus passengers, 436,398,745 local-railway passengers and 250,000,000 trunk-railway passengers from a 30-mile limit—a total of 1,908,846,973. Fatal street accidents rose from 155 in 1904 to 537 in 1912 and non-fatal from 10,384 to 20,166.

Three government departments are concerned in the regulation of matters connected with street traffic in London, yet none of them, nor all of them together, is responsible for the whole of it. The police in London are not under the municipal authority, but under the Secretary of State for Home Affairs. No one has, however, suggested any change as to the police.

Neither lack of lighting, the weather, nor the narrowness of the streets appears to have had any connection with the increase in the number of accidents and the evidence showed that a speed limit would not prove effectual.

There are many who have blamed the street cars for the increased number of accidents, but the report says

*96 Hurlingham Road, London, S. W.

that there is nothing to show that, even indirectly, this is so. In consequence of a communication from the London County Council (the educational authority) omnibus drivers stop before passing schools, a proceeding that the street cars have done for some time, the latter being under the London County Council authority. The report says that "the schools appear to offer the best means for instilling caution into the children in regard to the dangers of the streets, and periodical warnings might be issued through the schools to the parents."

In 1909, the City of London obtained power to regulate traffic through the streets and one order put into force was to compel certain streets to be used only in one direction, and it is stated that the effect "has been of great advantage in helping to solve in some degree the very serious problem of congestion and danger in the streets."

The Board of Trade inspects street railways in the same way and under the same acts of Parliament that they control the ordinary railroad. They go into the question of the safety of the staircase—all cars are double-deckers—and railings, proper lifeguards, sufficiency of brakes and other details as to the type of car and its fittings. The police, however, license the cars and make requirements as to the brake power. There is thus a dual control that is unnecessary and the report says that "the management should be responsible for a system of daily inspection, reporting of defects and repairs, which will secure that no vehicle shall appear on the streets in an improper condition. Where this system is effective and efficiently kept up, the police, who are overburdened with many duties, might have their work in this direction lightened. Diminishing street inspection and concentration on depot and garage inspection for fitness, would tend to reduce congestion."

The lifeguard on the front and rear of street cars has proved very effective. In the last three years it has been used on 135 occasions and on only five was it unsuccessful, and these involved children. In 1812-13, twenty-two million passengers were carried on the street cars to one fatal accident as against fourteen million in 1907-'08. The manager puts this down to the greater experience of the men, but admits that the public had "wakened up very considerably." Colonel Yorke of the Board of Trade ascribes it to the exercise of greater care by the motormen, to better discipline, the careful maintenance of lifeguards and to the brake equipment always being improved.

The London General Omnibus Co. controls, to a great extent, the running of omnibuses in London. Three years ago it had 863 motor omnibuses, carried 232 million passengers, and ran over 100 miles of streets. Now it has 2750 motor omnibuses, has more than double the number of passengers and runs over 350 miles of streets.

No evidence was presented to show that it has been possible to produce for the motor omnibus a lifeguard like that on the street cars, which is not in itself a source of danger. An expert who gave evidence said that he hoped for solid tires for omnibuses, made so that they will offer the probability of very greatly reducing, if not eliminating, the side-slipping danger. The same witness said that 504 different types of cowcatchers and side guards for omnibuses had been examined.

Complaints were made to the committee as to slow-moving traffic, but the report says that while in favor of the regulation of slow traffic it appears to the committee that the demand by drivers of swifter vehicles for its rigid control may be an indication of the impatience of the restrictions of city traffic; an impatience which also finds expression in a willingness to "take chances." A small, handy vehicle which can be easily accelerated will be guilty of "nipping in" on occasion and this is pointed out as a source of danger.

The committee considered that the practical difficulty of securing the safety of street-car passengers while they are crossing to the sidewalk is much exaggerated. The average duration of a street-car stop was found to be 8.65 seconds and it must be recognized, too, that if the street car were an ordinary road vehicle entitled to pass from the center of the street to the side, the delay to following traffic would be greater, and traffic would be again delayed while the car pulled out into the center of the road.

It appears that there is no speed register with sufficient accuracy to secure its adoption. The Board of Trade has been urging street-car authorities to equip them for the purpose of educating their men to judge rates of speed. The report says that both street cars and motor omnibuses should be equipped with such registers.

A recognized code of signals by motors is urgently needed. Every driver about to depart from his line of traffic (i.e., to turn either to the right or the left, or to slow down) should give a distinct signal to the traffic behind him. An indicator at the rear is suggested. Then, as the gong of a street car is an excellent warning of the type of vehicle approaching, it is recommended that motor horns be standardized also toward the same helpful end. Strong acetylene headlights should be prohibited in lighted streets.

In the summing up of the report, it is said that "it is agreed by all parties that the development of the motor bus has rendered very great service in London. It has brought residential suburban neighborhoods within the reach of people employed in the "inner ring." But the motor bus has got to be put under proper (administrative) control. With its great increase in size, weight, power and speed over its immediate predecessor, it must lose some of its privileges of irresponsibility. It has approached too closely to the tramway (street railway) standard of buik to be allowed to choose its path unrestrained and uncontrolled."

The omnibuses are privately owned, but the street cars belong to the municipality, and to give the latter body control over the busses seems against equity. Another peculiar feature is that the parochial authorities still retain a voice, as they can veto the admission of street railways, owned by the larger authority, into their parishes. The clerk to the London County Council said: "It seems to me to be somewhat a ridiculous position for a great city like London to be subject to the results of competition rather than the results of organization." His idea is "that a system of traffic could be instituted in London, by which the tramways and the motor omnibus service might be put to the very best use for the public with very considerably less danger than is the case at the present moment. We have two services, both equally wanted and I feel convinced that a proper scheme could be provided which would put those services to the very best possible use in the interests of the public."

The report, therefore, recommends that a new Traffic Branch of the Board of Trade shall be appointed to deal with the governmental supervision now exercised by three departments and that the London County Council be given the widest possible powers for controlling traffic in the streets, subject to the confirmation of the above Traffic Branch.

*

Pier for the Outer Harbor at Chicago

After many years of intermittent agitation and controversy over the establishment of an outer or lake-front harbor at Chicago, the construction of such a harbor was decided upon by the city, and the U. S. Government will provide the necessary breakwater protection. The first step toward carrying out the project will be the construction of a pier for passenger and freight purposes, and including also facilities for use as a recreation pier by the public. This harbor and pier work was noted in

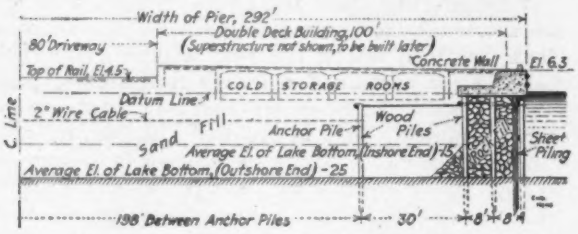


FIG. 1. HALF CROSS-SECTION OF STEAMSHIP PIER FOR THE OUTER HARBOR AT CHICAGO

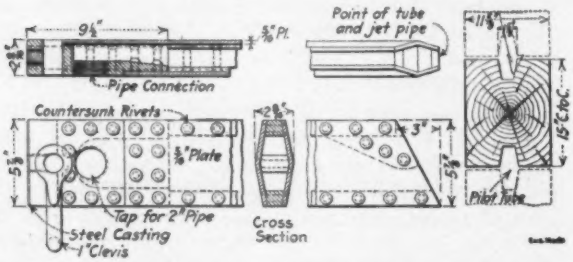


FIG. 3. SHEET PILING OF SQUARE TIMBERS, WITH COMBINED GUIDE AND WATER-JET TUBE

our issue of Aug. 28, and we give below some particulars of the pier construction, as shown by the plans and specifications just issued by the Harbor and Subway Commission.

The pier will be in line with Indiana St. (north of the river) and will commence at a bulkhead line 500 ft. beyond the present bulkhead line. It will be 3000 ft. long and 292 ft. wide, with a recreation space occupying 750 ft. at the outer end. For 2250 ft. from the bulkhead line, there will be a central 80-ft. driveway, with two tracks on each side, serving two double-deck buildings 100 ft. wide. Along each side of the pier will be a 6-ft. walk. Beneath the first floor of each building will be a basement for cold-storage and similar purposes. The general type of construction is shown in Fig. 1.

The pier will consist of two walls composed of sheet and round piling, with a rock fill between the piles and a concrete dock wall upon the piles, as shown in detail in Fig. 2. Behind this wall will be a line of anchor piles, connected to the main piles by tie-rods, the two lines of anchor piles being connected by 2-in. cables. The piles of the front row are to be 50 ft. long, and the interior piles 40 ft. long. Behind the sheet piling will be a fill of rip-rap stone, and the entire interior space then filled with sand dredged from the bottom of the lake.

The concrete dock wall will be 18½ ft. wide, 7½ ft. high for a width of 8 ft. on the water side and 3 ft. on the inner side. It will be built in sections, connected by keys, and will be reinforced as shown.

The concrete is to be made with gravel or broken stone, and to be a 1:2:4 mixture (measured by volume, with one bag of cement taken as a cubic foot). The concrete of the dock wall is to have a 3-in. facing (applied on the forms) of cement and sand (1:2). Concrete under water may be deposited by bottom-dump buckets or tremies.

The sheet-piling shown in Fig. 2 is of the Wakefield

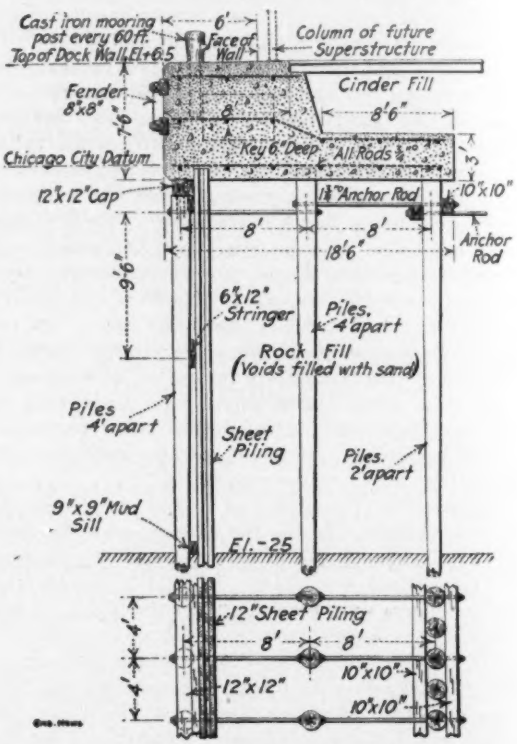


FIG. 2. DOCK-WALL OR FACE OF PIER

triple-lap type, but the plans provide also for square timber sheeting, as shown in Fig. 3. These timbers are grooved and may be fitted with oak or maple splines, or they may be driven by the aid of a guide or pilot tube, as shown in Fig. 3. This tube is of flattened oval section, and is utilized also as a jetting tube. The tube forms a guide for each pile, being withdrawn when the two adjacent piles are driven, and the space filled with a hardwood spline.

At the bulkhead line an 8-ft. passage or bypass is left open for the water, and is bridged by channel-shaped blocks of reinforced concrete, Fig. 4. The blocks which come under the railway tracks will have 9-in. I-beams embedded in the top, in addition to the reinforcing rods.

Each face of the pier will be protected by a continuous fender. This consists of a pair of 6x12-in. creosoted yellow-pine timbers let into recesses in the concrete wall and

fastened by anchor bolts to cast-iron sockets embedded in the concrete. Between them are vertical struts. To each of these timber wales is spiked an oak fender 6x8 in., faced with a ¾-in. iron chafing plate 4 in. wide. This fender construction is shown in Fig. 4.

Alternative Design

In a design submitted to the Harbor and Subway Commission by the Raymond Concrete Pile Co., the sheet piling is of concrete, and the concrete wall (of lighter section than that shown in Fig. 2) is braced by concrete struts bearing against heavy concrete blocks embedded in the sand fill. The wall and the concrete blocks would

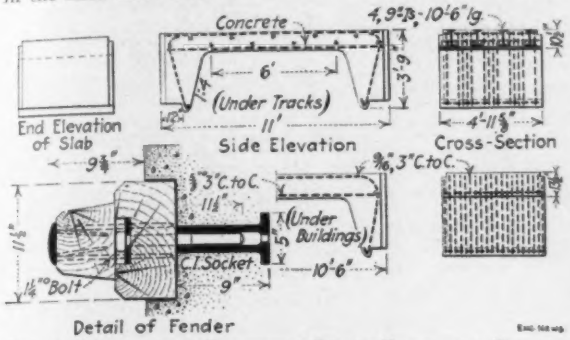


Fig. 4. Details of Concrete Slabs Spanning Bypass, and Fender on Face of Pier

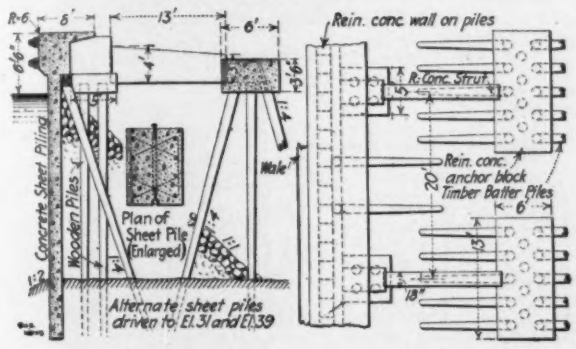


Fig. 5. Alternative Design for Pier, with Concrete Sheet Piling

be supported on timber piles and the sheeting backed by riprap. This construction is shown in Fig. 5.

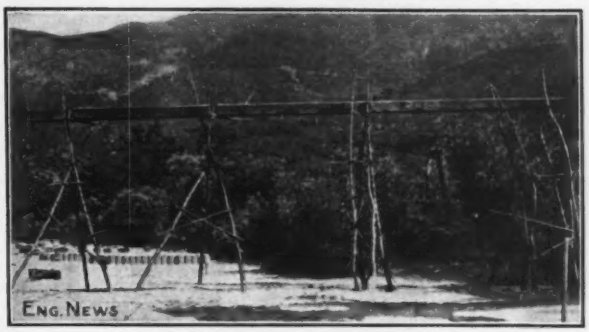
The sheet piles are shown as 24x18 in. in section, each reinforced with four ⅞-in. bars on the water side and four ¾-in. bars on the inner side, these being connected by hoops of ¼-in. wire, 12 in. apart. In one face of the pile is embedded a special bulb-bar, with the bulb projecting. In the other face is embedded a special socket bar, the socket (flush with the face) receiving the bulb of the adjacent pile. The stems of these bars are connected by straps or splice plates. These interlocking bars extend to 24 ft. below water level (and about 4 ft. below the bottom of the lake as dredged at the pier). Alternate sheet piles would be driven to 31 ft. and 39 ft. below the water line.

The dock wall is reinforced by counterforts 20 ft. apart, and against these are fitted the concrete struts, which rest in recesses in the wall and the anchor blocks. These struts are 18 in. wide, 4 ft. deep at the wall end and 3 ft. at the other end. The anchor blocks for each strut would be 13x6 ft., with a thickness of 3 ft. 6 in.

Irrigation Flume Built by California Indians

By H. K. Palmer*

The accompanying photograph shows a flume built by the Indians of the Rincon Indian Reservation, California, to carry the waste water from a well that was being dug across the dry river. The style of bents used is quite a departure from standard forms but it seemed to serve the purpose for the three months the flume was in use. A party of engineers camped on the reservation offered to give the Indians grades, but they preferred to use their



An Indian Irrigation Flume

own eyes. From the resulting grade the flume was known as the "Humpty Dumpty" flume and the capacity was only about half of what it might have been had the grade been even, even after the joints had tightened enough to reduce the leakage to 25%.

This flume saved the crops this year while the permanent irrigation system was being installed. The cement pipe shown in the background are for this system, the water being carried across the river by a siphon.

⁂

The Condition of the Railroad Grade Crossings in the southern part of New Jersey was the subject of a supplemental report by State Motor Vehicle Commissioner Job H. Lippincott to the State Public Utilities Commission, Aug. 26. The report describes the present conditions prevailing at the several grade crossings and recommends certain additional safeguards.

⁂

A Recent Peculiar Explosion at Hebburn-on-Tyne, England, in which two houses were wrecked and two persons killed has been determined to have been due to the formation of inflammable gas by the destructive distillation of bituminous insulation on buried electric wires. From a report on the case by W. M. Thornton and J. A. Smythe, of Armstrong College, Newcastle-on-Tyne (printed in London "Electrician," Aug. 22, 1913) it appears that the direct-current underground cables at this locality were insulated with good vulcanized bitumen, but had become displaced at a dip bend where the covering tile did not meet. Although protected by wooden troughing, moisture was thus allowed to penetrate. Some 6 ft. of cable was found destroyed and there was evidence that sooty vapors had passed in large quantity through a few inches of soil to the loose foundation stones of two nearby houses, and had gone through and collected under the flooring boards of the ground-floor rooms, in some way to become ignited. The floors were forced to the ceiling with such force that the two people standing on them were driven through and were found above.

Laboratory study of the gases made from the destructive distillation of Trinidad pitch from an adjacent section of cable showed that they varied in inflammability between marsh and coal gas, according as to whether they were freely and slowly evolved or rapidly forced over the hot coke residue of the bitumen.

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*Assistant Engineer, U. S. Indian Irrigation Service, Federal Building, Los Angeles, Calif.

Special Concrete Foundations in the Manila Port District*

By John W. Graham†

The section of Manila known as the "port district," is almost entirely reclaimed land. It was made by pumping material from the bottom of Manila Bay and depositing it back of a rock sea wall by a hydraulic dredge and pipe line. The depth of this fill is, in general, between 20 and 30 ft. The work was completed in 1905.

The bottom of Manila Bay near the mouth of the Pasig River, to a depth of at least 100 ft., is covered by a deposit of very finely divided silt, including considerable sewage and similar waste products, mixed with fine coral and sand.

As the port area fill was made by the hydraulic process, the different classes of material were deposited in different locations, the coral and sand in belts near the pipe line, and the silt and finer materials at greater distances. These beds of sand and coral are compact and have fair bearing power. They are limited in extent, however. The silt, or mud, which comprises the greater part of the district is free from voids and saturated with water. It is practically incompressible and acts as an imperfect fluid. Vibrations caused by a truck passing over a road built on this material can be easily felt 100 ft. distant. Its bearing power is negligible.

Most of the buildings which will be constructed in this district will be storehouses with office room as a secondary feature. These buildings will have the main storage room on the ground floor, with offices and light storage on the second floor. This type of construction will concentrate only moderate loads on the pier foundations, but the ground floor loads will be comparatively heavy, probably ranging from 1000 to 2500 lb. per sq.ft.

A number of tests of the bearing power of the soil, and experiments to determine the most economical method of increasing this bearing power, have been made by the Bureau of Public Works in connection with the construction of the two warehouses for the Bureau of Supply.

One of the first of these tests was made on a section of road at a point near the east end of the present buildings.

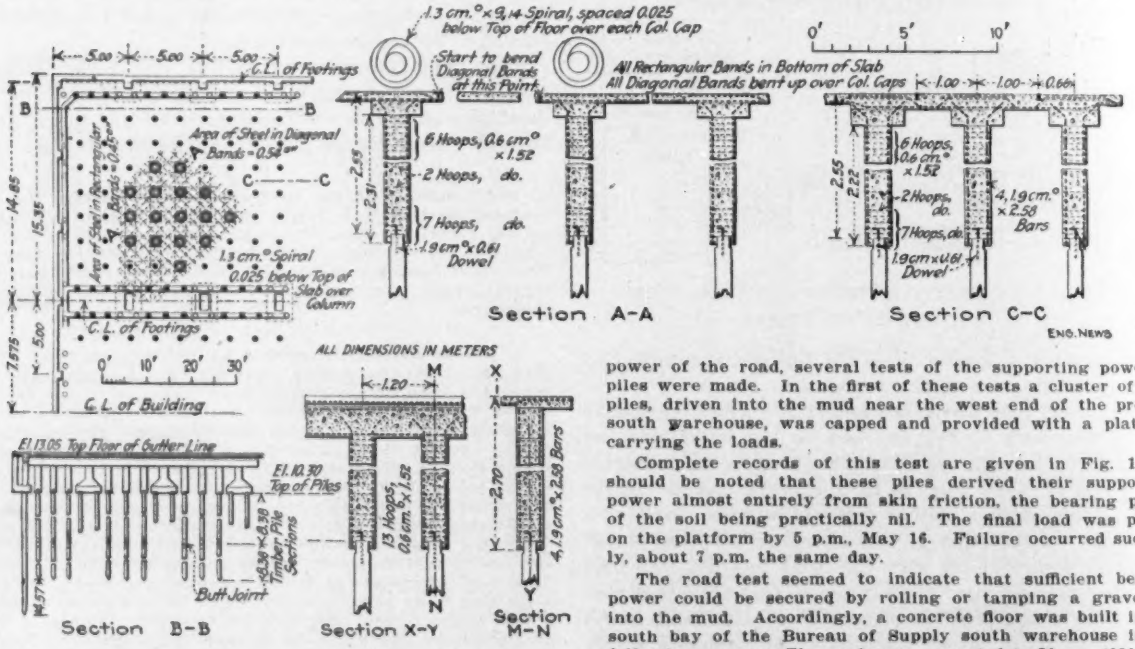
1.3 cm.°×9.14 Spiral, spaced 0.025 below Top of Floor over each Col. Cap
Start to bend Diagonal Bands at this Point
All Rectangular Bands in Bottom of Slab
All Diagonal Bands bent up over Col. Caps
5.00
C.L. of Fixtings
Area of Steel in Diagonal Bands = 0.54 sq in
6 Hoops, 0.6 cm° ×1.52
2 Hoops, do.
7 Hoops, do.
1.9 cm°×0.61 Dowel
1.3 cm.° Spiral 0.025 below Top of Slab over Column
C.L. of Footings
C.L. of Building
Section A-A
Section C-C
4, 1.9 cm.° ×2.58 Bars
ENG. NEWS
ALL DIMENSIONS IN METERS
El. 13.05 Top Floor of Gutter Line
El. 10.30 Top of Piles
13 Hoops, 0.6 cm. °×1.52
4, 1.9 cm.°×2.58 Bars
6.30 Timber Pile Sections
Butt Joint
Section B-B
Section X-Y
Section M-N

FIG. 2. SPECIALLY DESIGNED CONCRETE-FLOOR CONSTRUCTION, WAREHOUSES ON MADE LAND, MANILA, P. I.

The discharge of one of the dredge discharge pipe lines was located near this point, so that the fill here is composed almost entirely of shell. The road cross-section at this point was made up as follows: Material in fill, 5 in. of shell, 5 in. earth and sand, 4 in. refuse talim stone of 3- to 4-in. sizes, 9 in. broken talim stone of ½- to 2½-in. sizes. The original surface settled about 10 in. under the roller.

Six pieces of 8 by 12 in. by 5 ft. timber were laid side by side on the ground and on top of these a platform was erected. The load was placed on this platform in 5-ton increments and readings were taken between each increment. A total load of 100,882 lb. was placed upon the platform.

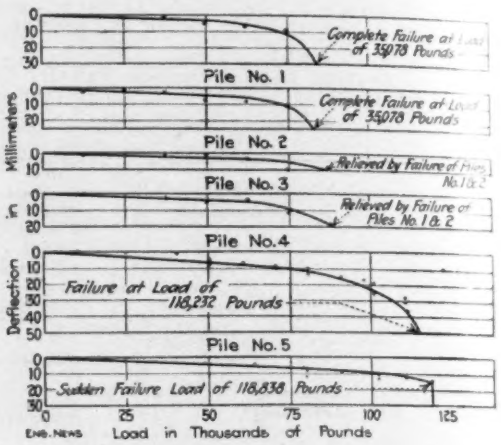
Pile No. 1
Complete Failure at Load of 35,078 Pounds
Pile No. 2
Complete Failure at Load of 35,078 Pounds
Pile No. 3
Relieved by Failure of Piles No. 1 & 2
Pile No. 4
Failure at Load of 118,232 Pounds
Pile No. 5
Sudden Failure Load of 118,838 Pounds
Millimeters
Deflection
ENG. NEWS
Load in Thousands of Pounds

FIG. 1. DEFLECTION CURVES; BEARING POWER OF PILES; MADE LAND, MANILA, P. I.

Under this load the road failed completely, the timbers settling till the platform rested on the ground. The failure was practically local, extending only a few inches beyond the edge of the timbers.

In addition to the above-described test of the bearing power of the road, several tests of the supporting power of piles were made. In the first of these tests a cluster of four piles, driven into the mud near the west end of the present south warehouse, was capped and provided with a platform carrying the loads.

Complete records of this test are given in Fig. 1. It should be noted that these piles derived their supporting power almost entirely from skin friction, the bearing power of the soil being practically nil. The final load was placed on the platform by 5 p.m., May 16. Failure occurred suddenly, about 7 p.m. the same day.

The road test seemed to indicate that sufficient bearing power could be secured by rolling or tamping a gravel fill into the mud. Accordingly, a concrete floor was built in the south bay of the Bureau of Supply south warehouse in the following manner: The mud was excavated to 50 cm. (19½ in.) below the finished floor elevation; a layer of Pampanga sawali was placed at the bottom of this excavation; on the sawali gravel was tamped and leveled to a plane 15 cm. (6 in.) below the finished surface; a 15-cm. (6-in.) concrete slab, in sections 2.5 m. square, was built on the gravel; no reinforcement was used.

A timber bin, approximately 16 ft. square, was built in the center of the third panel from the west end of the building and filled with sand weighing 98.75 lb. per cu.ft. Under a load of 395 lb. per sq.ft. the floor settled from ¾ to 2½ in. at different points. Complete failure was caused by a load of 900 lb. per sq.ft.

*From the "Quarterly Bulletin," Bureau of Public Works, Manila, P. I., April 1, 1913.

†District Engineer, Batangas, Philippine Islands.

DRIVING RECORD OF PILES TESTED, BUREAU OF SUPPLY WAREHOUSE SITE

Pile No.	Date driven	Length: Below ground feet	Length: Above ground feet	Diameter: Tip, inches	Diameter: Butt, inches	Settlement due to own weight ft.	Settlement due to own weight in.	Settlement weight of hammer ft.	Settlement weight of hammer in.	Blows	Free fall of hammer feet	Average penetration last 6 blows struck, inches	Kind of Hammer	Weight, pounds	2 WH / S 1
1	Apr. 10, 1910	44.6	1.15	8½	13½	10	0	34	6	12	2	4	Steam.....	3,000	2,400
2	do	44.3	1.15	7½	12½	11	4	34	6	18	2	6	do	3,000	1,710
3	do	44.3	1.15	9½	13	10	5	33	8	20	2	5	do	3,000	2,000
4	do	44.6	1.15	8½	12½	14	2	34	4	14	2	4	do	3,000	2,400
5	Oct. 1, 1909	60.6	4.92	.....	9½	8	0	.....		45	10	5½	Drop.....	2,000	8,000

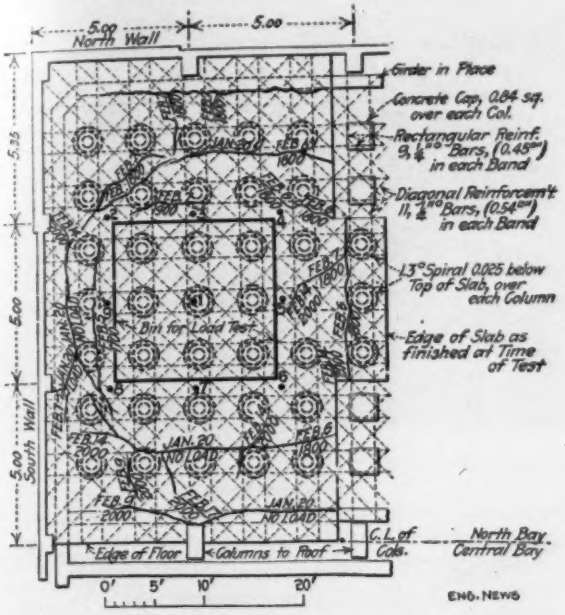

FIG. 3. TEST OF CONCRETE-FLOOR CONSTRUCTION, MANILA, P. I.

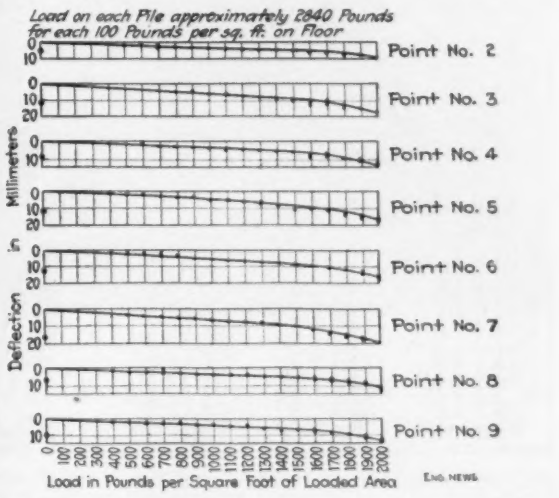
Load on each Pile approximately 2840 Pounds for each 100 Pounds per sq. ft. on Floor
Point No. 2
Point No. 3
Point No. 4
Point No. 5
Point No. 6
Point No. 7
Point No. 8
Point No. 9
Millimeters
Deflection
0 10 20
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Load in Pounds per Square Foot of Loaded Area
ENG. NEWS

FIG. 4. CURVES SHOWING DEFLECTION OF CONCRETE FLOOR UNDER LOAD TESTS

A section of the same floor, over the shell at the east end of the building, was loaded in a similar manner to 1000 lb. per sq.ft. and showed a total settlement of 6 mm. (¼ in.) The load remained in place for nine days.

These failures having destroyed faith in the gravel-fill plan, various methods of pile construction have been considered. Sand piles, although cheap, are too liable to displacement to be considered in a region subject to earthquake action. Concrete piles are expensive and would add considerably to the dead weight to be carried by the soil. Their strong point, permanency, is also possessed by timber piles driven below the permanent saturation point. Timber piles also are comparatively cheap and easy to handle.

A design for a concrete floor, supported on timber piles, to carry a load of 1000 lb. per sq.ft. was prepared by the division of engineering design. It is shown in Fig. 2. Two panels of floor, in accordance with this design, were finished in the Bureau of Supply south warehouse about the middle of September, 1912. A section 16 ft. sq., near the center of this slab, was tested between Sept. 30 and Oct. 3, 1912.

A timber bin was built of 2x12 in. by 16 ft. horizontal planks, with 4x4-in. exterior braces thoroughly wired together. The bin was filled to a height of 9 ft. with sand weighing 104.38 lb. per cu.ft. Under this load the maximum settlement at any point was 8 mm. (⅓ in.) The cracks shown in Fig. 3, were caused by subsequent tests as no load cracks were caused by this test.

A second test of the same floor was begun Jan. 21, 1913. A bin similar to that above described was located as shown on Fig. 3. Sand was loaded at the rate of 100 lb. per sq.ft. every day except Sundays, until a total of 2000 lb. per sq.ft. of the loaded area had been reached. This load was allowed to remain for nine days until all settlement had ceased.

Readings were taken four times daily until the final load had been placed, and thereafter once daily at the points indicated on Fig. 3 to determine the floor deflection. Readings to determine the lateral movement of the walls, were taken at the same time. The results of the observations on the floor have been plotted in Fig. 4. The observations for lateral deflection were entirely negative.

A comparison of the curves of Fig. 4 with those of Fig. 1 would indicate that the load applied was approaching very closely to the load which would cause failure. Possibly 2500 lb. per sq.ft. is a fair assumption for this load, which would make a factor of safety for the floor of 2.5.

The concrete floor made a remarkably good showing under very severe conditions. It was first tested to the load for which it was designed when less than a month old. Then after six months it carried twice the designed load, with supports yielding nonuniformly, and only showed one small crack inside the loaded area.

The writer believes that the above tests have demonstrated that this type of floor can be built to carry any reasonable load required. It is not a cheap method of construction, but the advantage of having storehouses located near the water front will more than offset the extra cost of construction in this district.

⁂

A Prize Competition for River Improvement Plans, for the improvement of navigation on the Upper Rhine between Basel and Constance, has been organized by the Verein für die Schiff-fahrt auf dem Oberrhein, at Basel, to which should be addressed all inquiries for a program of the competition. Plans must be submitted before Dec. 10, 1914, and prizes of $9500, $6600 and $4700 are being offered.

⁂

An Automatic Revolving Door, collapsible in case of panic, so as to permit free egress, was exhibited at the Grand Central Palace, New York City, where the convention and exhibition of the International Association of Fire Engineers was held, Sept. 1-6. The door is revolved by an electric motor and ordinary pressure on the brace arm or push plate starts the motor, and turns the door. Discontinuing the pressure breaks the circuit, bringing the motor to a stop. Should the vestibule become overcrowded from any cause, so that the pressure upon the door increases beyond the ordinary limit, the doors and the wings forming their approach automatically collapse, thus permitting free exit passage. Although the doors are easily collapsed, the ordinary pressure used in their regular operation does not affect the proper working of the mechanism. This mode of operation, involving merely pressure on the push plate is of recent development. The doors are made in two styles, oak and bronze; two of the latter are at present installed in the Kinney Building, Newark, N. J. These doors are manufactured by the Van Kannel Revolving Door Co., New York City.

Harbor Construction at Kobe and and Yokohama, Japan

By Wilson T. Howe*

The new port works at Kobe, Japan, were described in Engineering News, Mar. 2, 1911, p. 261, and the details of the reinforced-concrete caissons which make up the pier structures, in the issue of June 1, 1911, p. 647. The present notes, supplementary to the articles noted above, are the result of a recent visit to Japan, at which time the writer had the privilege of seeing the plant and works both at Kobe and Yokohama, where also large docks were recently completed.

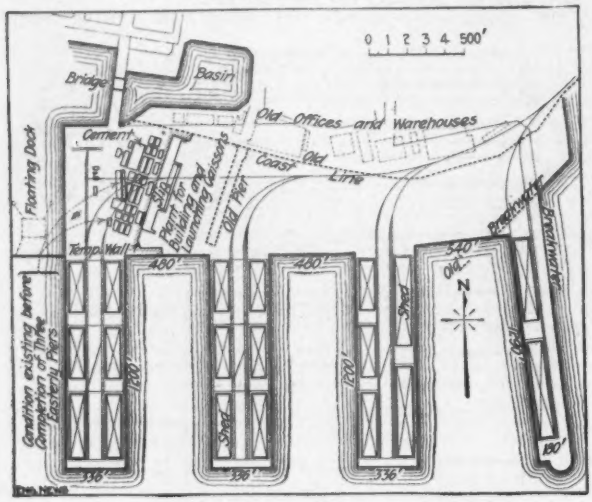

Fig. 1. Layout of Proposed Piers for New Harbor at Kobe, Japan

Kobe Harbor

Fig. 1 is a plan showing the layout of the piers as it will be when the work is completed. The new bulkhead line is some 700 ft. south of the old one and from it extend four large piers, each provided with a number of sheds, mechanical handling devices and ample docking space between. In addition, a curved breakwater, 3792 ft. long, is to be built to the eastward of the piers. The total work to be done comprises the construction of the piers and breakwater, the dredging necessary to make the piers effective, the reclamation of the foreshore between the new piers and the old shore line, a new approach to Pier 4 (which includes a bridge over a tidal estuary leading to a basin for small craft) and the necessary railway connections, streets, sidewalks, water-supply, sewerage, lighting, etc. Piers 2, 3 and 4 are to be completed to the full dimensions shown; one-half, only, of Pier 1, or the westerly side, will be completed at present, leaving its ultimate completion until the future extension of the harbor is undertaken.

Piers 2, 3 and 4 are each to be approximately 1200x336 ft., with slips 480 ft. wide between them. Each pier carries steel cargo sheds in two lines, separated by transverse and longitudinal streets, and the arrangement is one shed at each of the 19 berths which the present project is designed for. Pier 1 is designed for one berth of 36-ft. and one of 33-ft. depth. The eastern side of Pier 2 has two 33-ft. berths, and the remainder are 30-ft. berths. This arrangement of sheds is common in Japan, the new docks in Yokohama being similar in layout.

In the construction of the port, sufficient filling was first done to make wide land approaches to Piers 1, 2 and 4. Upon these approaches were built the various parts of the construction plant, in the locations shown in Fig. 1. In the rear of Pier 3 is an old pier, which was to be continued in use until new berthing space was provided and consequently the construction of this pier was left until the last.

The most interesting part of the work is the method of building, launching and sinking the reinforced-concrete caissons used in the pier section. These caissons of the general size and type shown in the part section through the pier, in Fig. 1, are cast in place on a building slip on the new-made land (location shown in Fig. 1), from which they are lifted by the launching pontoon described in article of June 1, 1911, and carried to deep water when the pontoon is sunk to a depth sufficient to float

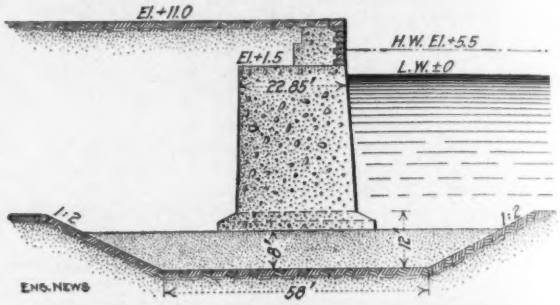

Fig. 1-A. Typical Section through Pier

Fig. 2. Slip in Which Concrete Caissons Are Made

*Greenville, Tenn., formerly Principal Asst. Engineer, Division of Port Works, Bureau of Navigation, Manila, P. I.

the caissons. The caissons are then towed to their proper location, where they are sunk and filled.

Fig. 2 is a view in the building slip, showing the first step in the construction of a caisson, the laying of the reinforcement in the floor. This slip is arranged for the construction of four caissons at once. For convenience of construction it is served by a four-story scaffold, which the view shows plainly. In each story are stored forms and other material for use as needed, and as the form for the caisson is built up, tracks through each story bring the concrete in cars out over the form, an elevator taking the loaded concrete cars to the proper story.

The outer, or sea side, of the scaffold, is built on trucks, and is capable of moving longitudinally, it being carried on a track laid on the outer piles of the building slip. When a caisson is completed and ready for launching, this movable part is run to the position shown in the view, the rails and track timbers removed, allowing the launching pontoon to enter, lift and remove the caisson from the building slip.

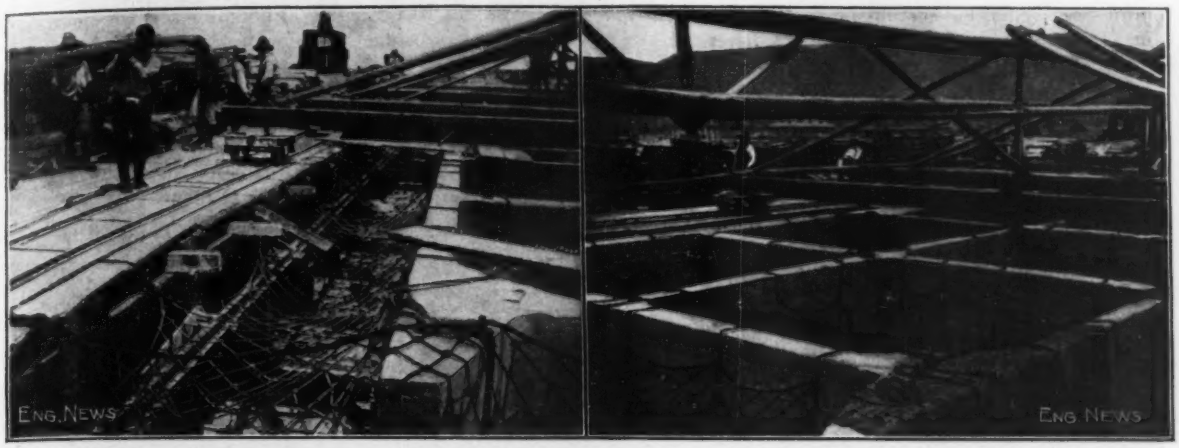

FIG. 3. ROPE LIFE NETS FOR PROTECTION OF WORKMEN, CONCRETE CAISSONS, KOBE, JAPAN

FIG. 4. PIER SHEDS AND FREIGHT-HANDLING CRANES, YOKOHAMA, JAPAN

The section in Fig. 1-A shows the typical cross-section through the side of a pier formed of caissons. No attempt is made to secure unyielding footings for the caissons, which would be impossible at Kobe without piles, but a bottom is prepared by excavating to a depth of 8 ft. below the bottom of the caissons, and backfilling this trench with sand and gravel to the proper grade. After the caisson is sunk, a 4-ft. thickness, or mattress, of small rubble stone is placed on the sea side to prevent scour. It would be interesting to know the behavior of these structures in regard to settlement after completion.

The views in Fig. 3, taken from the top of the scaffold of the building slip, show in part the tops of finished caissons, and the use of the rope life nets is an interesting detail from which a lesson might be learned in the protection of workmen from accidents in countries where life and labor are not reckoned so cheap as in Asiatic countries. The launching dock was very fully described in the later of the two articles noted above.

YOKOHAMA HARBOR

Fig. 4 shows view on the new docks just completed at Yokohama. In addition to the low one-story cargo sheds seen on the faces of the piers, the Yokohama arrangement also provides an elaborate system of three-story buildings to be leased for warehouses, lofts, factories, etc. A central electric-power station is provided within the inclosure to furnish light and power, and communication between all parts of the docks is had by a railway system and good paved streets. The extensive use of rickshaws in Japan makes the latter a necessity everywhere. There is also a canal tributary to the harbor, with cargo sheds alongside, in which lightered cargo is handled. This feature of special provision for lighter traffic is always manifest in foreign ports, and the principle could be developed to advantage in this country.

Sewage Treatment Plant for a Sanatorium

By P. H. Norcross*

The city of Louisville, and Jefferson Co., Ky., jointly maintain an institution known as the Waverly Hill Anti-Tuberculosis Sanatorium. This institution is situated approximately ten miles from Louisville, on a high ridge, and is about four miles from the Ohio River.

It is necessary to purify the sanitary wastes of the hospital before discharging them into natural drains. Dr. Dunning S. Wilson, Medical Director of this institution, after a thorough study and investigation, recommended the installation of a sewage-disposal plant that would deliver a nonputrescible effluent, and also one that would be highly clarified. This was necessary, because of de-

Fig. 1. General View of Sewage-Treatment Plant for Waverly Hill Anti-Tuberculosis Sanitorium, near Louisville, Ky.

composition that might tend to take place in the natural drains, which are, a large portion of the year, absolutely dry.

The plant finally adopted consists of a screen chamber, Imhoff tanks, sprinkling filters and, finally, an intermittent sand filter. A sludge bed was added to dispose of the sludge from the Imhoff tanks. Fig. 1 is a general view of the plant and Fig. 2 shows a number of its details.

The plant was completed and placed in operation on Jan. 18, 1913, and is now producing a highly purified and perfectly clear effluent.

Screen Chamber—The crude sewage first enters the screen chamber, in which is placed a screen composed of 1¼x¼-in. bars, spaced approximately 2 in. c. to c. The sewage is discharged from the screen chamber by shear gates, into the pipe lines that convey the sewage to the Imhoff tanks. Two gates are provided, so that the flow of the sewage can be turned in either direction, depending upon the desired operation of the tanks.

Imhoff Tanks—The Imhoff tanks (Fig. 2) are in duplicate, each 9x11 ft. in plan, and have an inside depth of 17 ft. The time of the flow of the sewage through the tank varies from 1½ to 4 hours, depending upon the hour of the day. The pipe lines are so arranged that the sewage can be turned in either direction, in one or both tanks. The sludge compartment is so designed that accumulations of sludge can be stored for six months or longer. The sewage after being clarified in the Imhoff tanks is conducted to an overflow or weir chamber, where it is bypassed to the dosing tank.

Dosing Tank—The dosing tank consists of a sloping sided, concrete tank, which holds about 600 gal. of clarified sewage at high head. A 5-in. Pacific flush tank sew-

age siphon discharges the sewage onto the sprinkling filters. The maximum working head is 6½ ft. above the orifice of the nozzles.

Sprinkling Filters—The sprinkling filter (Fig. 2) is one unit, 22x44 ft. in plan, with crushed stone approximately 6 ft. in depth. The sewage is conducted to eight nozzles through four lines of 4-in. cast-iron pipes. These lines branch off from a 6-in. cast-iron feed pipe, controlled with gate valves, so that any or all of the nozzle lines can be cut off. The feed pipe and valves are in a pipe gallery parallel with one side of the bed. Taylor square nozzles are used, which produces a uniform distribution of the sewage over the surface of the stone.

Under the stone, there is a system of 6-in. diameter half-tile underdrains, which collects the filtered sewage and discharges it into a drainage channel, in the center of the filter. Two revolving copper ventilators give additional aëration to the crushed stone. The outlet of

*Of Solomon-Norcross Co., Engineers, Atlanta, Ga.

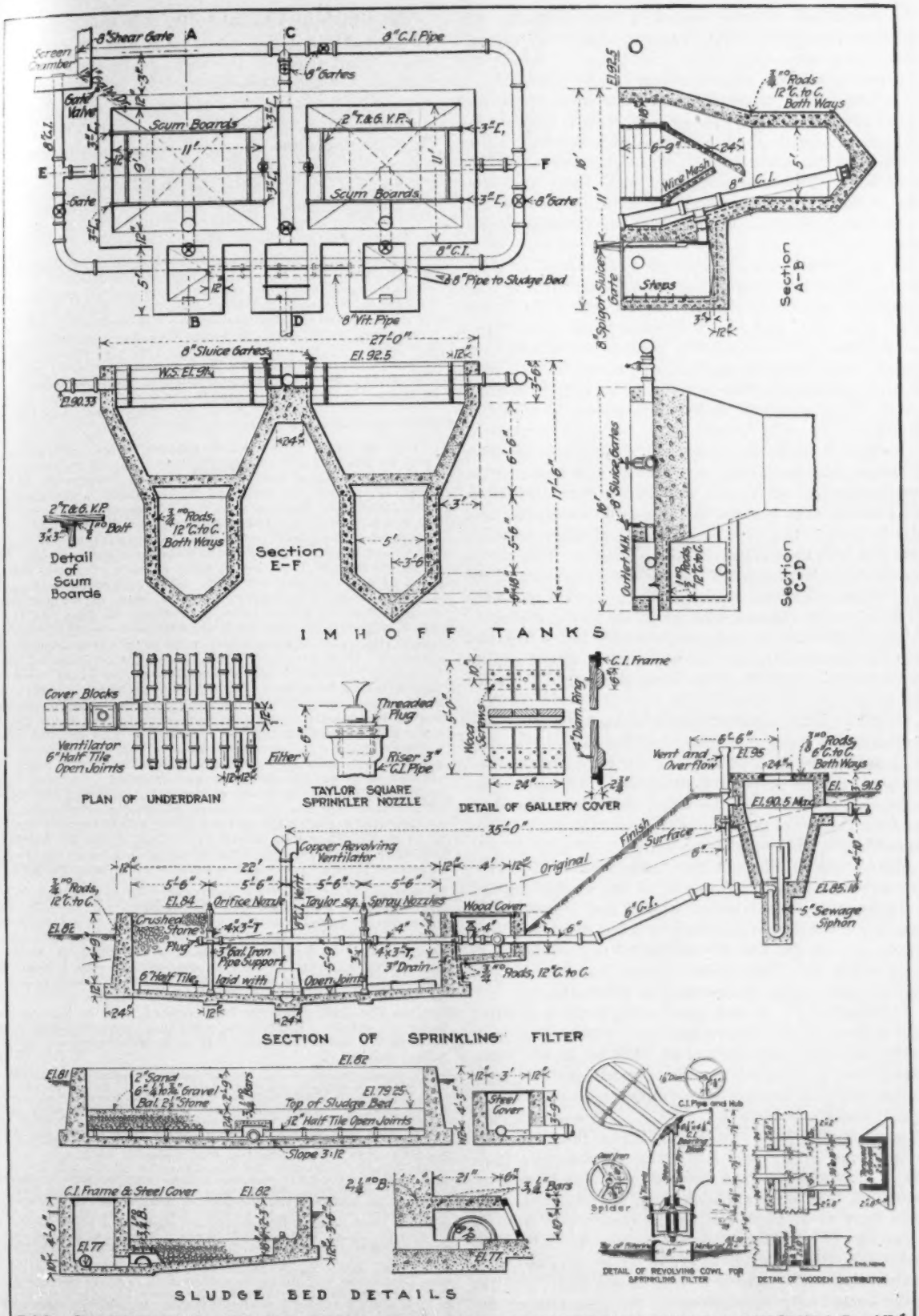

FIG. 2, DETAILS OF SEWAGE WORKS FOR SANATORIUM NEAR LOUISVILLE, KY.

the sump of the filter is trapped so that air passing into the filter through the ventilators can escape only through the crushed stone, thus assisting oxidation. There is also a bypass so that the sprinkler lines can be blown off.

INTERMITTENT SAND FILTERS—The sand filters consist of two beds, 20x40 ft. in plan, with a large dosing chamber in which are located two standard 5-in. Miller siphons, which alternately discharge the sewage onto the sand beds. This dosing tank is made large enough so that if, in the future, it is desired to disinfect the effluent from the plant, it can be done with very little additional cost.

A departure was made from the usual design of intermittent sand filters, as it was desired to underdrain the beds more effectively than is usually done. To accomplish this, 6-in. half tile, with open joints, were placed on the floor of filters on 2-ft. centers throughout their length, and a drainage channel was placed in each filter so that the sewage that is collected is quickly drained away. A detail of the distributor appears as a part of Fig. 2.

SLUDGE BED—In the design of the sludge bed, another departure was made from usual practice by inclosing the bed in concrete walls, and providing a concrete bottom. This was done to prevent the growth of weeds, etc., and also to prevent the washing of earth and other materials over the bed, thus destroying its efficiency. The sludge bed is made large enough for the future growth of the institution and sludge coming from the Imhoff tanks can be dried on the bed and used for filling in low places.

The liquid that comes from the sludge bed is bypassed into the line leading into the intermittent filters, so that this sewage is purified before being discharged from the plant.

GENERAL DATA—All of the details of the plant are permanent in every particular, and the design is simple, so that the operation of same is easily understood, and the plant can be properly maintained. The location selected is ideal for a plant of this character. The sewage from the future growth of the institution can be taken care of by the addition of extra units.

CHARACTER OF SEWAGE AND OPERATION OF PLANT—The larger portion of the volume of the sewage disposed of by the plant is laundry wastes, and consequently, there is a great deal of suspended matter, due to saponification, and as the specific gravity of this character of waste is less than that of water there is a great deal of floating waste upon the surface of the tanks.

A large portion of this goes through the sprinkling filter and on to the intermittent sand filters. The sand filters, therefore, perform a dual function in the treatment of the sewage, yet the Imhoff tanks perform their work so well that there is not an unusual amount of clogging of the upper surface.

In connection with the specifications for the intermittent sand filter, sand having an effective size from 0.35 to 0.48 mm. was specified. It was found upon investigation that to obtain such sand, a prohibitive price would have to be paid, and as the sand would have to be purchased from distant points, it was decided to use local "Ohio River" sand, which could be obtained very economically. This sand is very clean and sharp, and has proven exceedingly satisfactory in the operation of the plant. Renewals and upkeep on same will be at a nominal cost.

The plant was designed by the Solomon-Norcross Co., Consulting Engineers, of Atlanta, Ga. W. H. Sallee was resident engineer in charge of construction. The National Concrete Construction Co., of Louisville, Ky., was the contractor. All of the material was delivered at a siding, one mile haul from the plant. The cost of the plant, including all piping connections, between the component parts, and the grading and shaping up of the grounds, was approximately $6500. This figure does not include engineering.

A Floating Factory for ship-repair work is planned by the British Admiralty, and bids for its construction have been asked from shipbuilders. It is proposed to build a rectangular hull 450 ft. in length and 90 ft. broad, with square ends. This hull will support a superstructure containing a foundry, machine shop, boiler shop, electrical shop, blacksmith shop, pattern shop, and other departments. The hull will be divided into watertight compartments, which will be used for coal storage and for a steam power station, in which current will be generated, supplying power to the various parts of the factory. Above the factory living accommodations will be provided for about 136 officers and men.

Oxygen for enriching the air supplied to iron blast furnaces is to be tried by the Ougree-Marihaye Co., of Belgium. According to a paper read by Mr. Gustave Trasenster, of this company, before the Iron and Steel Institute, the company has adopted the liquid-air process of manufacturing oxygen, for the purpose of obtaining oxygen on a large scale at a low price. The plant used has been supplied by the Liquid Air Co., of Paris, working on the Georges Claude system. The plant consists of three units, each capable of producing 200 cu.m. of liquid oxygen per hour. Each unit consists of an air compressor, with a capacity of 1200 cu.m. of air per hour, compresed to 225 lb. per sq.in., a liquid-air machine and tower which utilizes the compressed air delivered, to effect the final liquefaction and separates the liquefied air into oxygen and nitrogen. It is necessary that the air to be liquefied shall have every trace of carbon-dioxide and moisture removed. The latter is done by a battery of dessicators in which the air is pased over calcium chloride. To remove carbon-dioxide the air is passed through two towers containing brick checkerwork kept wet with a soda solution. The present plant requires about 1 hp. per cubic meter of oxygen produced per hour. Large machines now being built with a capacity of 1000 cu.m. of oxygen per hour are expected to improve this record and reduce the power consumption to about two-thirds of a horsepower per cubic meter of oxygen produced.

Experiments with the oxygen in the blast furnace are yet to be made. They will consist first of enriching the hot blast delivered to the furnace with oxygen, and later of the use of oxygen alone in a small, specially built blast furnace.

Generosity of Old-Time Surveyors—The surveyors of the United States Forest Service are finding that the old land measures of forest land in the eastern part of country generally erred on the side of safety—that is, to the advantage of the owner or buyer of the land, who ordinarily employs the surveyor. This is further evidence of the honest endeavor of the pioneer surveyors to give their employers full measure. The old idea was to be sure and include as much land as the deed called for and enough over to have a fair factor of safety. Particulars regarding some of these early surveys are given as follows in a statement issued by the Forest Service:

In surveying mountain lands in the Southern Appalachian and White Mountain regions with a view to government purchase under the Weeks law, the Forest Service surveyors found that the tracts, in many cases, contained more land than the acreage set by the original surveys. Taking the region as a whole, the acreage of lands surveyed by the government exceeded by 1% the acreage believed to be in the tracts by the people offering the lands for sale.

In certain instances the discrepancies of the old surveys, made generally with a compass and by surface measurements, are much more than this amount. Such an instance is that of a tract in northeastern Tennessee, which was supposed by the owners to contain 850 acres. The survey by the Forest Service, made with a transit and by horizontal measurements, credits the tract with 1,481.88 acres. Over-runs of this kind amounting to from 5 to 8%, have been shown in a good many tracts.

On the other hand, these increases are partly offset in other cases in the rougher hill country, where the old surface measurements unintentionally gave an excess over the actual amounts the tracts contained by the government's horizontal surveys. Perhaps the most frequent cause of shrinkage is in the location of overlappings by some older grant, which results in the elimination from the tract of some part or parts which had been considered as belonging to it.

Present Stage of Construction on the New York State Barge Canal

By Emile Low*

It has been announced by the State Engineer and Surveyor of New York that the New York State Barge Canal will be completed on May 15, 1915. In view of this announcement the stage of progress on the canal up to July 1, 1913, should be of interest. Most of the following data were taken from the *Barge Canal Bulletin*, a monthly publication issued by the State Engineer.

To July 1, 1913, the value of the work under contract on the Barge Canal on 114 contracts was $78,107,448, which is exclusive of 6 contracts on the Cayuga and Seneca Canal, whose value is $3,778,529. The total value of work done on the 114 contracts is $57,187,205, and on the other six, $1,427,640; about 71% of the total work let is completed. Forty-four contracts have been finished and 76 are in various stages of completion. Table I shows the estimated cost of the 120 contracts let up to July 1, 1913.

TABLE I.

Miles	No. of contracts	Canal	Value of work	Per cent. finished
355	70	Erie	$56,506,307	75
62	20	Champlain	10,911,506	88
23	14	Oswego	6,104,445	67
	5	Water Supply	2,683,589	60
	5	Power	1,901,601	12
15	6	Cayuga and Seneca	3,778,529	38
Totals.....	120		$81,885,977	71

In addition to these, plans are in progress on 15 various contracts, likely to aggregate several million dollars, being the Rochester harbor dam, dredging in the Hudson River, the movable dam at Scotia, various bridges, power houses and lock equipment.

Table II shows the details of the expenditures:

TABLE II.

Canal	Value of work done to July 1, 1913	
Erie, 26 contracts finished	$11,059,665	
Erie, 44 contracts in progress	31,613,990	$42,673,655
Champlain, 10 contracts finished	5,738,190	
Champlain, 10 contracts in progress	2,833,320	8,571,510
Oswego, 5 contracts finished	371,608	
Oswego, 9 contracts in progress	3,734,660	4,106,268
Water supply, 2 contracts finished	890,299	
Water supply, 3 contracts in progress	721,190	1,611,469
Power, 1 contract finished	171,633	
Power, 4 contracts in progress	52,670	224,303
Cayuga and Seneca, 6 contracts in progress	1,427,640	1,427,640
Totals, 120	$58,613,845	$58,614,845

Some of the smaller contracts embrace work on several of the main divisions of the canal, as in the case of bridges, lock gates and power equipment, so that the exact cost of each individual section, Erie, Champlain and others, will not be known until the final completion of all work.

The complete contracts are in isolated sections. It cannot be said that there is a continuous stretch of considerable length finished, although many adjoining contracts are in advanced stages of completion.

On the Erie Canal, the section between the Mohawk River at Waterford and the same river below Crescent, a length of 2.5 miles is finished. This comprises contracts Nos. 2, 2a and 11, which includes Locks 2, 3, 4, 5 and 6, being the land line north around the Falls of the Mohawk, the river having a total fall here of 170 ft. About 7 years have been spent in building this section. The next contract, No. 14, includes Locks 7, 13, 14 and 15, in the Mohawk River, and located at Vischer's Ferry, Yosts, Canajoharie and Ft. Plain. This section is 86% finished.

Contracts Nos. 17, 18 and 31, comprising Locks 11, 12, 16 and 17, at Amsterdam, Tribes Hill, Castle Creek and Little Falls are also completed. Contracts Nos. 20a, 20b, 20c and 20d, comprise dredging a section of the Mohawk River between Rexford Flats and Little Falls, 59 miles long. Taken as a whole these four contracts are 50% finished. Contract No. 20c is almost finished, while considerable work remains to be done in Nos. 20a, 20b and 20d, especially the latter.

Other unfinished work in this vicinity is Lock 8 and Dam 4 at Scotia and incidental work pertaining to the completion of Locks 9 and 10 at Rotterdam and Cranesville, being Contracts Nos. 8 and 8a.

Between Little Falls and New London, a distance of about 40 miles, occur Contracts No. 30, 29, 42, 42a, 43 and 44, which comprise excavation, and Locks 18, 19, 20, 21 and 22, and also the Rome Summit Level and the change of the New York Central R.R. at Rome. This section is about 50% finished. A number of the contracts are in a backward condition regarding progress, especially Contract No. 42a, which was originally No. 42. To complete this part of the canal by May 15, 1915, will require energetic prosecution.

Another completed section is Contract No. 4, extending east from Oneida Lake for about 5 miles. Between Oneida Lake and Rochester, a distance of about 110 miles, the only completed contracts are Nos. 45, 5, 5a, 41 and 6, at Baldwinville, Montezuma swamp, Irondequoit Creek and Rochester. The most extensive contract in this section is No. 12, which is 44 miles long, mostly in the Oneida and Seneca Rivers. It is 78% completed. Other advanced contracts are Nos. 76, 77 and 63, the latter is the one in which the canal break at Irondequoit Creek occurred in September, 1912, and fully reported in Engineering News at the time.

On the section between Rochester and Tonawanda, a distance of about 90 miles, Contracts No. 60, 9 and 66, at Spencerport, Albion and Lockport, are finished and the remainder of the work is in an advanced state of completion, except Contracts Nos. 65 and 83, the latter not yet let. It is expected to complete the Lockport Locks and the section between Lockport and Tonawanda, comprising Contracts Nos. 67, 40 and 19, during the fall of 1913.

Table III shows the amount of work remaining to be done:

TABLE III.

Canal	Contracts	Amount
Erie	44	$13,832,652
Champlain	10	2,339,996
Oswego	9	1,998,177
Water supply	3	1,072,120
Power	4	1,677,298
Cayuga and Seneca	6	2,350,889
Totals	76	$23,271,132

For the year ending July 1, 1913, the value of work done was $12,146,652, or roughly $1,000,000 per month. Even should the contracts yet remaining to be let aggregate several or more millions of dollars, an average expenditure of slightly more than a million dollars per month would complete the whole work by May 15, 1915.

*606 Ashland Ave., Buffalo, N. Y.

The Employment of Convicts on Road Work in New Jersey was authorized by the state legislature of 1913.

Operations of the Garbage-Reduction Plant, Columbus, Ohio, 1912

The municipal garbage-reduction works of Columbus, Ohio, were described and illustrated in our issue of Nov. 17, 1910. The following information regarding changes made in the plant in 1912 and on the operations of the plant during the year is taken from the annual report of Irwin S. Osborn, engineer-in-charge, design and construction.

During the past year the drying equipment was changed from steam dryers to direct heat dryers for drying all material.

This work consisted in the removal of two vacuum mixing dryers, the installation of one new direct heat dryer with necessary furnaces and chambers and the rebuilding of the revolving steam dryer. The drying equipment was changed by the contractor who made the original installation to complete contract and the City was put to the additional expense of constructing foundations, and the labor required in rebuilding the revolving steam dryer. The changes made resulted in doubling the capacity of drying equipment and permits the drying of all material during the day shift of eight hours. It also permits the drying of material at less cost for labor, fuel and supplies. In connection with changes in dryers tests were made in treatment of off gases and methods developed for deodorizing them. Deodorizing condensers are now being installed and provision made for deodorizing all gases in high temperature furnaces.

The addition of the percolating plant which was placed in operation during the month of January, 1912, proved a very good investment with very satisfactory results being obtained. Previous to the operation of the percolator the only recovery of grease was made by pressing so that the material when dry contained approximately 10% of grease which was not recovered. During the year all solids were percolated and the yield of grease from the plant increased approximately 40%.

The percolating plant was constructed at an approximate cost of $20,000 and during the year 203½ tons of grease was recovered by percolation, valued at $16,891. The cost of operating the percolatory plant including fuel, labor, gasoline, and supplies amounted to $4602, making an earning from percolation amounting to $12,289, which is about 60% of the original investment.

OPERATING RESULTS FOR 1912 COMPARED WITH 1911

	1911	1912
Garbage Reduced, Tons		
January	1,062.08	1,224.64
February	977.03	1,048.87
March	1,114.75	1,172.55
April	1,175.22	1,221.91
May	1,364.05	1,373.64
June	1,371.39	1,353.52
July	1,613.47	1,808.30
August	2,147.44	2,295.57
September	2,270.71	2,425.47
October	1,719.28	1,842.35
November	1,355.58	1,550.74
December	1,361.88	1,471.91
Total	17,534.49	8,789.47
Average tonnage per day	56.56	60.03
Expenditures		
Supervision and labor	$21,680.58	$24,170.86
Coal	5,964.58	7,422.73
Electric power	1,921.45	1,305.95
Repairs and renewals	1,305.36	1,717.73
Supplies	882.26	3,163.09
Office expense	271.21	181.01
Chemical analysis	290.45	223.00
Miscellaneous	166.37	299.32
Total cost of operation	$32,482.26	$38,503.69
Receipts from Products		
Grease	$34,324.54	$42,559.52
Tankage	23,163.64	17,537.04
Hides	1,217.07	1,544.49
Miscellaneous	16.50	87.57
Total	$58,721.75	$61,728.62
Receipts over expenditures	$26,239.49	$23,224.93
Revenue per ton garbage reduced	3.35	3.29
Operating cost per ton	1.85	2.05
Receipts over expense per ton	$1.50	$1.24

The figures given above do not include a fixed charge for interest and depreciation. Interest on bonds amounts to 4% and sinking fund for average life of plant would be 3.36%. As repairs and renewals are charged to operation a fixed charge of 7.36% on original cost of $210,000, amounting to $15,456, would be sufficient, which if deducted from receipts would show an earning over and above all charges.

The greatest factor affecting the operation of the plant in making a comparison of the year 1911 with 1912, is the decrease in the market price received for byproducts. Had the same prices prevailed in 1912 as were received in 1911, the total receipts would have been increased $13,000 with the same cost for operation.

⁂

An Engineering Course for $20 in 1837

Not only was the cost of living cheaper some 75 years ago, but also the cost of an engineering education—if an advertisement which ran for several weeks in the *American Railroad Journal* in 1837 can be relied upon. This advertisement was worded as follows:

A COURSE OF INSTRUCTION IN CIVIL ENGINEERING, by informal lectures, to occupy two months, commencing the 1st week of May—comprising

The use of the theodolite, level, Compass, plain table, cross, and sextant explained upon the instruments themselves; topographical drawing executed under supervision; survey of routes; problems of excavation and embankment; railroad curves; all the actual details of construction upon common roads, railroads, and canals; including bridges, culverts, tunnels, and various kinds of motive power; nature, strength and stress of materials; masonry, carpentry and construction in iron; alluvial deposits, "guaging" of streams, &C.—The whole purely elementary. Terms of admission to the course, $20.

Apply to C. W. Hackley, Professor of Mathematics in the University.

It may be added by way of explanation that this was perhaps the greatest boom period in the history of engineering, the days of wild-cat railway building, canal construction and toll-road development. At that time every man with a hundred dollars believed he could double it yearly in some branch of the transportation business. "Engineers" were in great demand. The same year saw the first movement toward the formation of a national society of engineers.

⁂

The Mineral Production of the Union of South Africa for June, 1913, acording to statistics of the Mines Department of the Union, was as follows: Gold, 748,570 fine oz., valued at $15,453,463; silver, 81,139 fine oz., at $48,488; coal, 753,926 tons, at $924,177; base metals other than coal, valued at $754,432. Of the latter copper and tin lead in value, lime asbestos, flint, magnesite and graphite following. The number of persons engaged in this production, at the mines, were 31,761 whites and 283,504 colored. Seven of the former were killed and 38 injured in 282 separate accidents, which took place during June, while of the colored labor 85 were killed and 191 injured.

Stone Production in 1912—The value of the stone produced in the United States in 1912 was $78,284,572, an increase of $1,176,005 over 1911, thus breaking all previous records. Pennsylvania has always held first rank among the stone-producing states except in 1908, when Vermont reported the largest production. In 1912 the Keystone State produced 11.68% of the total of the entire United States, with Vermont second, producing 9%. Other large stone-producing states, named in order of output, are New York, Ohio, Indiana, California, Illinois, Massachusetts, Missouri and Wisconsin, the production of each of which was valued at more than $2,000,000.—U. S. Geological Survey.

Exports from the United States to Japan in 1912-13 were larger than ever before and a few million dollars in excess of our total exports to all other countries in Asia. The total was $57,315,000, divided as follows, according to the U. S. Department of Commerce:

Raw cotton is the largest single item in the exports to Japan, though manufactures as a whole show a larger total than that of the single item—cotton. The value of raw cotton exported to Japan in 1912-13 was $25,000,000 against $11,750,000 in 1911. Flour totaled $3,330,000. Products of iron and steel are the most important of the manufactures exported to Japan, pipes and fittings in 1913 being $1,365,000; sheets and plates, $1,335,000; locomotives, $1,335,000; rails for railways, $1,250,000; structural iron and steel, over $500,000; nails and spikes, over $400,000; railway cars, $150,000, and tin plates, approximately $100,000. Other manufactures sent to that country include illuminating oil, $4,500,000; lubricating oil, over $500,000; sole leather, over $500,000; fertilizers, nearly $500,000; and numerous other articles in smaller sums.

EDITORIALS

The New York Rules Governing Mine, Tunnel and Quarry Work

The New York legislature at its last session enacted a law providing for an Industrial Board, with the Commissioner of Labor as the chairman, and empowered the Board to pass and enforce rules to secure the safety of workmen engaged in mining, quarrying and tunnel work. On Sept. 8 the acting Commissioner of Labor sent out a preliminary draft of proposed rules governing this class of work and announced that a hearing upon these rules would be held in Albany on Wednesday, Sept. 17.

The notice was received by ENGINEERING NEWS too late for inclusion in our last week's issue; and it seems worth while to protest against such brief notice being given to the mining, quarry and tunnel industries of the State of New York in a matter of such importance. There is no question as to the propriety of the State regulating operations in these industries to secure the safety of employees and of the public; and a commendable spirit is shown in holding a public hearing upon the proposed rules before putting them in force. But the busy men whose interests will be affected by these rules are given only one short week's notice of this hearing and many cannot find spare time in that period to give careful study to these rules. Not only this, but many and perhaps most of them will have no notice of the hearing until it is over. It would seem that at least a month's notice of such a hearing should have been given and the rules should have been widely circulated in advance so as to secure the largest amount of intelligent criticism.

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The Need for Water-Waste Prevention at Philadelphia

The valuable paper on the Torresdale filtration plant of the Philadelphia water-works, read Sept. 10, before the New England Water Works Association, raised once more the old question as to why Philadelphia will persist in wasting water by the billion gallons. For a quarter, if not half a century, that city has presented the spectacle of an overworked water-supply system, often on the verge of collapse at many points, simply because the people insist on uncontrolled wastefulness of water at the sacrifice of efficiency, economy and safety to life and property. All this has been urged again and again by successive Chiefs of the Bureau of Water, but to no avail.

Some of our readers will remember that before the construction of filters was begun, the board of consulting engineers pointed out that by adopting water-waste-prevention measures a much smaller plant would suffice than would otherwise be necessary and millions of dollars would be saved. That sort of talk fell on deaf ears. The people wanted to continue their unbridled waste of water and the political bosses and contractors wanted to build as large filtration plants as possible. More or less vague promises were made to the effect that once the filters were built waste curtailment would be employed to keep the consumption and waste down to the capacity of the filters, so the latter would serve without enlargement for years to come.

That the promise has not been kept is plainly evident from the paper which we have already mentioned. In the breathless attempts to keep up with water consumption and waste, quality of water and economy of operation and maintenance have been sacrificed to the fetich of mere quantity—the same old cry for any sort of water so long as it is wet and plentiful. Makeshift methods of cleaning the filters and high rates of filtration have been employed when with a normal consumption neither would have been necessary and the bacterial results would have been better. True, much trouble has been caused by occasional high turbidity, but a reasonable per capita rate of consumption in Philadelphia would have saved money enough in pumping and filtration and other charges to pay the capital and operating charges on a sedimentation basin or some other means of coping with high turbidity.

It is certainly high time that public opinion in Philadelphia came to the support of the water bureau and made it possible to cut down the wicked waste of water that has gone on there for so long a time. A vigorous use of well known waste-prevention measures, including district and more localized waste and leakage surveys, the use of consumer's meters and perhaps a revised schedule of flat and meter rates, would work wonders in a few years, greatly aiding the crippled city treasury, giving added safety against fire, and still further cutting down the typhoid death rate.

⁂

The Australian Capital Once More

If on occasions American engineers become discouraged at the politician's control of engineering activities, they may console themselves with the reflection that the fault lies in human nature and not in American institutions. There is abundant evidence that the evil is world-wide, but its latest manifestation comes from Australia in connection with the sadly confused competition for the design of the new capital city of the federated states of the island continent.

It will be remembered that generous prizes were offered about two years ago for designs of this city to be newly built in a semi-wilderness and that somewhat later* the first prize of £1750 was awarded to Walter Burley Griffin, a Chicago architect, who lately has made quite a specialty of city planning. It was naturally to be expected that Mr. Griffin would receive more than the mere prize money, which, though of sizable proportions is not to be compared with the honor and satisfaction of having a responsible part in the design and construction of a world city.

*"Engineering News," July 4, 1912, p. 41.

However, local professional jealousy, aroused by the fact that no Australian engineer or architect had a design premiated, and political maneuvering by the government officials, prevented the normal procedure in this competition and at the same time brought down upon the government the criticism of professional city planners the world over.

Briefly, the government announced that the three prize winners should receive only their prizes and that their designs, together with a number of unrecognized designs, should be turned over to government officers who would prepare an official plan to be followed in the construction of the city. Such procedure was followed and a government plan was born which was neither fish, flesh nor good red herring.

For a while it looked as though Mr. Griffin would have to be satisfied with his $8500, but during the past few months a change has come over the scene. A Liberal government has succeeded a Labor government and the engineers and architects of Australia petitioned the new government for a royal commission of inquiry to go over again the plans for the nation's capital. At the suggestion of one of the board which awarded Mr. Griffin the first prize, the government has asked that gentleman to visit Australia and to confer with the board of inquiry as to possible amendments and alterations to his plan.

At present it is difficult to predict a complete divorce of the political elements from the design and construction of the city, but at least things look brighter for a fair result of the competition and incidentally for Mr. Griffin.

Large Testing Machines and Government Work in Testing Materials

In giving a picture of the 3300-ton testing machine at Berlin, on another page, we show the world's largest testing machine. The vertical machine which Olsen built for the Geological Survey and which is now at Pittsburgh, under control of the Bureau of Standards (though erected to only half its full height) is of greater capacity, 5000 tons, but this can hardly be called a testing machine in the full sense of the word, because it is incapable of tension tests and from its nature, as well as the original intent of its construction, is specially adapted to only a narrow range of work, such as large stone blocks. Perhaps the largest and most modern among real testing machines for comparison with the Berlin giant is the 1200-ton horizontal Emery machine recently set up in the Washington laboratory of the Bureau of Standards. The capacity of this machine is enormous, according to our ideas of four or five years ago, yet it is only about a third as much as that of the machine at Berlin. At the same time the Emery machine is vastly more cumbrous to handle.

In speaking of these two large testing machines, one is unavoidably led to think also of the two institutions with which they are connected. Both are very large institutions, not far from equal, perhaps, if measured in floor space or other physical units. Regarded as testing institutions, however, there can hardly be any reasonable comparison. The Bureau of Standards, though it is gradually developing a testing laboratory, is still chiefly a physical research and standardization laboratory; while on the other hand the Gross-Lichterfelde laboratory—the Königliche Materialprüfungsamt—has by more than a dozen years of the most active and intelligent efforts fairly won the title of the greatest testing institution in the world. Comparison between the two institutions, therefore, will show a far greater discrepancy than that between the two large new testing machines above mentioned.

It is but natural to think of comparing the Berlin and Washington institutions, because, broadly speaking, they are the only national testing laboratories in existence; at least Austria, Italy, France and England have no similar institutions. The exact study of materials is rapidly growing in importance as well as in complication, and every day makes it more apparent that in the multitude of active private interests which surge around questions of materials or their defects an authoritative governmental laboratory which will decide disputes or investigate doubtful points is of the utmost value. The great possibilities of such a laboratory are clearly illuminated by the vast amount of highly important work reported in the periodical reports of the Prussian institution.

No doubt, those who amalgamated the testing interests of the government departments under the control of the Bureau of Standards three or four years ago, and brought from the Geological Survey and from the Ordnance bureau of the War Department their miscellaneous testing work (conducted often under difficulties and with conflict of interest) were animated with the idea that in time an institution similar to the Gross-Lichterfelde Laboratory would grow up. Unfortunately, very little has yet been produced by the Bureau of Standards to show that it is working toward the realization of such ideas. The Bureau's work has, in fact, been so largely concerned with electrical details that many regard it as being essentially an electrical laboratory; and, correspondingly, the people interested in other subjects who looked to the Bureau for necessary test work in support of industrial and professional advance have been disappointed and have lost interest in the organization.

But if a comparison of the Königliche Materialprüfungsamt and the Bureau of Standards results very unfavorably to the latter as a testing institution, it must be remembered that the Bureau is young. If an active development in the right direction is begun soon, it may become as important a factor of technical advance in the United States as the Prussian testing institution has become for German progress.

Steel Passenger Cars and Safe Railway Practice

The fatal rear collision of Sept. 2 on the New Haven railroad which we discussed last week is being made the text for an active propaganda to secure legislation making compulsory the use of steel cars in passenger service. The movement has received considerable impetus from the very good showing made by steel cars in the derailment of the Pennsylvania's 24-hour train from New York to St. Louis which occurred on Sept. 9, four miles west of New Madison, Ohio. The derailment occurred near a small stream crossing where the embankment was washed away in the flood of last April. It is supposed that unequal settlement of the embankment was respon-

sible for the derailment. Of the eight steel cars composing the train, six went down the embankment and turned on their sides in a corn field; only the last two remained on the roadbed. No one was killed in the wreck; but three persons received injuries believed to be fatal, and some thirty-five others were more or less seriously hurt. The train is said to have been running at high speed when the derailment occurred. In the press reports of the accident, great emphasis is laid on the claim that the casualties would have been far greater had not the cars been of steel.

On the same day that the news of the accident was received, there appeared the Interstate Commerce Commissioner's report on the investigation of a rear collision at Tyrone, Penn., on the Pennsylvania R.R. on July 30. In this collision the Philadelphia and St. Louis express, consisting of a locomotive and eight cars, all but one of them of steel, struck the rear of a passenger train of steel cars standing at Tyrone station, the speed at the time of collision being estimated at 30 to 35 miles per hour. The Interstate Commerce Commissioner's expert says in his report "the substantial construction of the modern steel cars making up these trains is without doubt the reason that none of the passengers were killed."

The results in these two accidents are being widely quoted as positive proof that steel-car equipment is the best safeguard of travel by rail. A bill has been introduced in Congress by Senator O'Gorman, of New York, requiring all railways to replace wooden passenger cars with steel by Jan. 1, 1918. A law requiring postal-car equipment to be of steel after a certain date is already on the statute books.

It is furthest from our desire to oppose any reform looking to greater safety in railway operations, but before enacting hasty legislation of this sort Congress will do well to give heed to the relative importance of other needed improvements in railway safety practice. It ought to consider the question how much money the railways can spend on safety equipment during the next five years or ten years or whatever period may be fixed. It must consider also where and how that money is to be obtained, and in what directions it should be expended in order to produce the greatest results in the saving of lives and limbs.

There is little doubt that in case derailment or collision occurs to a steel car, the passengers inside it have *rather better chances* than they would have if the car were of wooden construction. But that is the most that can be said, although from some of the current newspaper discussion one would suppose that passengers inside a steel car were safe no matter how it might be knocked about in a collision or a derailment.

Suppose, however, it were decided to make compulsory the substitution of steel passenger cars for wooden cars, not on all the railways of the United States, but on all the railways which conduct a fast train service. What would such a change cost?

Of the total mileage of railways in the United States, probably half to two-thirds consists of branches, spurs and local lines with moderate traffic. The amount of rolling stock used on these lines, however, is comparatively small by reason of their light traffic. Of the total of some 50,000 passenger cars in service in the United States, therefore, probably at least four-fifths are in service on main lines where they are, if not run in fast trains, at least subject to the risk of being struck by fast trains. Making allowances for the number of steel cars already in service, therefore, it is safe to say that at least 35,000 wooden cars should be, and doubtless eventually will be, replaced with steel.

The cost of a modern steel passenger coach is in the neighborhood of $15,000, depending on its dimensions, finish, etc. Taking this as the average price, the cost of 35,000 such cars would be the enormous sum of $525,000,000. The task of finding the money for such a large addition to rolling-stock equipment during the next four years would be one which, without doubt, would give railway financiers some anxious moments, to say the least, in view of the many other pressing demands upon the railway exchequer. This problem would be easy, however, compared with the problem of finding the cars. It need hardly be said that all the steel passenger-car building establishments in the United States could not produce that number of coaches or anything like it in the next four years. It may be urged that new shops could be built to supply the demand; but the establishment of a plant equipped to turn out first-class steel passenger cars is not a thing that can be done in a few months. Even were it possible to establish such plants at enormous cost and rush the equipment through in the time stated, it is easy to see that at the expiration of that time these plants would be lying idle, having completed the work they were built to accomplish, and with no further market for their product. Such a wasteful use of manufacturing capital would be an injury to the public as well as to the railway interests, were it made compulsory by legislation. It is just such overbuilding of manufacturing capacity during boom periods that has frequently brought about financial panics and resultant distress.

There is still another aspect to the steel-car problem. It appears to be assumed that the present steel car is a finality, and that all the railway has to do it to give out an order for steel cars and everything will be perfect. Every engineer familiar with steel-car construction, however, realizes that we have only made a beginning in this art. Those most familiar with the details of steel-car design agree that there are large opportunities for improvement. For one thing, steel cars, as well as most other railway rolling stock, have too much dead weight for economical transportation. It should be possible by economical design to considerably reduce the present weight of these cars thereby effecting a great reduction in the cost of transportation.

If we assume that a steel passenger car will travel a million miles during its life—not an extravagant assumption—then every needless pound of weight put into that car must be hauled that million miles. That is the equivalent of 500 ton miles of work. If we estimate the cost to the railways of hauling that extra weight at so low a figure as one mill per ton mile, then 50 cents expense by the railways will be saved for every pound that the car is made lighter in its original construction.

Again, it is by no means certain that we have reached finality in other details of car construction, the protection of the metal from corrosion, for example. It may even be that the steel car of the future will be so designed as to offer still more security against telescoping in collision than do present steel cars.

All such improvements in design would be literally

thrown to the winds were any such hasty legislation enacted as has been proposed. Manufacturers alter their designs and make improvements under the stress of competition and through a desire to get orders. All of these forces tending toward improvement would be neutralized if the railways were compelled by law to make large contracts for cars so that the car builders could practically dictate prices and terms and force the use of their own designs.

What seems most important of all, however, is that the other directions in which railway practice needs improvement should not be overlooked, as they are likely to be if the agitation for steel cars has full sway.

As we said last week, the perfection of the block-signal system and block-signal discipline on all the main line railways of the United States is the most important reform to be made looking to the safeguarding of railway train service. Of even greater importance for saving lives is the removal of grade crossings, especially those in towns and cities. These are the directions to which outlays for safety from the railway treasury should first be directed.

LETTERS TO THE EDITOR

Foreign Requirements Governing Work under Compressed Air

Sir—Referring to the New York law governing work under compressed air and to Mr. Frank Richards' letter about an oversight in said law, as printed in ENGINEERING NEWS of Aug. 28, in regard to proper ventilation of the lock during the period of decompression; it is evident that if the men were not taken dead out of the lock, as Mr. Richards fears, they would surely feel nauseated or have all the symptoms of the first stages of asphyxiation after spending half an hour or more in a crowded lock without ventilation.

As Mr. Richards states, the condition of the air in the heading of a tunnel may be expected to be much better than in a caisson, particularly so if the face is fairly open. This seems to be about the only reason for the law to call for 24 min. for decompression from a 36-lb. pressure and 40 min. from a 40-lb. pressure in a tunnel, whereas it calls for 20 min. for decompression from a pressure of 36 to 40 lb. when work is done in a caisson. Otherwise, it would seem that owing to cramped space and other disadvantages of the caisson work the men ought to be required to take more precautions and to spend more time in locking out than the men working in a tunnel.

The laws of the Netherlands and those of France regulating work in compressed air are more specific and more complete in so far as they relate to locking in and out and as to the lock itself. Article 28 of the Netherlands Regulations states that:

> The lock must have an interior height of 1.80 m. and a floor area of 0.30 sq.m. per man up to a pressure of one atmosphere; of 0.35 sq.m. per man for a pressure of from one to two atmospheres and of 0.40 sq.m. per man for a pressure greater than two atmospheres; in the latter case benches must be provided so that the men may sit down.
>
> Article 29—The ventilation of the lock shall be properly provided for.
>
> Article 30—At the bottom of the lock shall be a removable perforated floor.
>
> Article 31—Men shafts shall not be obstructed by tubes or pipes of any description.
>
> Article 32—The lock shall be cooled or heated as the case may be unless means have been adopted to prevent the exterior temperature from having any direct influence thereon.

The French Law, enacted on Dec. 17, 1908, states:

> Article 7—The volume of air per man in the lock will never be less than 0.6 cu.m. for any head of water up to 20m. and 0.7 cu.m. for any greater hydrostatic head.
>
> The ventilation of the locks, during decompression lasting more than 10 min. shall be obtained by working simultaneously the valves controlling the inlet and outlet of the air to and from the locks, such valves being of different sizes.
>
> In summer the locks exposed to the sun shall be protected by a tent or by straw mats sprinkled with water.
>
> The supply of air will be such that the amount of carbonic acid in any sample of air taken at the longest distance from the point of delivery of the air pipe will not be greater than 1.5 in 1000 for pressures under two atmospheres and one in 1000 for higher pressures; this percentage to correspond to a supply of 30 to 40 cu.m. of pure air per hour per man.
>
> A sample of air will be taken and analysis thereof made whenever the supply of air will fall below 40 cu.m. per hour.

The passage through the lock during the decompression is often uncomfortable and this explains the haste with which the men are anxious to lock out. The proper ventilation of the lock will improve the quality of the air as well as prevent condensation to some extent.

This condensation and the resulting cold are chiefly objected to by the workmen, and this seems plausible enough since instances have occurred when the temperature dropped from 36° C. to 5° C. This condensation, however, is due to a rapid decompression; when this decompression is effected uniformly and at a speed of one-tenth of an atmosphere per minute, there is no appreciable condensation and hardly any drop in temperature, this lowering of temperature being opposed by the radiation of 300 to 400 calories given by the men, figured at an average of 75 calories per man per hour.

The French Law has not prescribed, as does the Dutch Law, the distribution of woolen clothing to the men when locking out but requires that such recommendations as to clothing and other hygienic measures be printed and posted in the locks and about the works.

The great difficulty is to reconcile theoretical regulations and practice and to convince the men of the necessity of using discretion in locking in and out. In view of the unwillingness of the men to spend the theoretical specified time in the lock, I found that the best way was to strike some happy medium by fitting the inlet and outlet valves with blank flanges perforated in such a way that even by opening these valves in full, the time spent for compression or decompression would not be less than, say one-half to two-thirds the specified time and for long decompression to keep the exhaust valve open wide and the inlet valve partly open proportionately to the pressure and the theoretical time of decompression.

PAUL SEUROT.

Montreal, Can., Sept. 6, 1913.

The Influence of Petty Pay-Roll Economies on Labor Conditions

Sir—The testimony brought out at the meeting of the Arbitration Board in connection with the difficulties between the Boston Elevated Ry. and its employees has raised an issue which, it seems to me, is an important factor in a majority of all strikes and internal dissensions.

The evidence has shown that "turn-back crews" have not received, in all instances, the full amount of compensation due them as allowed by the official wage schedule. This unfairness is due obviously to the person in immediate charge of the men and their time distribution, who took upon himself the additional authority of interpreting the wage schedule to suit his own particular ideas of economy.

While there is no doubt that such a method of procedure is financially economical for the time being and also tends to make a "showing" in the financial accounting of the maangement of that department, the inevitable results of this action have proved that it is far from being actually economical in every sense of the word.

During the past ten years I have seen numerous instances of such additional, self-imposed authority, assumed by men of minor official positions. While the results are not always a concerted strike, I believe that it is to a great degree responsible for the constant coming and going of workmen. In individual cases the workman obtains no satisfaction. He simply "chucks up" the job and announces to his fellow-workmen that he has received what is commonly known as a "rotten deal." It is only through the unanimous voicing of their objections that workmen can protect themselves from this ill-assumed authority.

Although a company or corporation may feel that it is not accountable for such actions on the part of men in charge and may have every honest desire and intention of living up to its agreements, the fact that officials have failed to acquaint themselves with the actual condition of affairs should be no excuse. It should be the duty of these officials to see that the rules and agreements are fully and impartially carried out by the department heads, with the same zealous care that they use in seeing that employees obey the rules and regulations. It is a deplorable fact that there are many men in inferior official positions who are prone to resort to petty, picayune methods of manipulative management.

T. N. Ashton.

Fall River, Mass., Sept. 4, 1913.

NOTES AND QUERIES

The article in our issue of Aug. 7, p. 276, on the life of Robert Escobar and the letter in our issue of Sept. 4, correcting the same, failed to state that Joseph Mayer was Chief Engineer of the Union Bridge Co. during the latter part of its existence. In the original article it was erroneously stated that Mr. Escobar was Chief Engineer.

In the course of substituting later data in the article "Typhoid Fever in Large American Cities," by George A. Johnson, published on pp. 473-5 of our issue of Sept. 4, 1913, some errors occurred: Scranton was omitted from the cities having "all kinds" of purification, shown in the diagram at the top of p. 474. In the corresponding table on the same page, in the line giving the "Number of cities" having no purification and using various sorts of treatment the column headed "None" should have read 18 instead of 13; "All kinds," 33 instead of 30; and "Rapid sand filtration," 9 instead of 8. The note to the same table should have been omitted. On p. 475, column one, the last two sentences of the second paragraph should have read:

Hence, to cause 2600 deaths some 36,000 people would have suffered from the disease. If we assume that lost time and medical attendance will average a cost of $150 for each case, we have the sum of $5,400,000 to add to the value of the lives saved, making a total saving of $18,400,000 annually, due to the reduction of typhoid fever alone.

Also on p. 475, last sentence, $19,000,000 annually should have read $18,400,000 annually.

Annual Convention of the New England Water Works Association

About 250 engineers and water-works officials attended the 32d annual convention of the New England Water Works Association held in Philadelphia, Penn., Sept. 10 to 12, inclusive. Mayor Rudolph Blankenburg welcomed the visitors to the city and complimented the engineering profession upon the efficient and zealous support its members have given his reform administration in Philadelphia. Morris L. Cooke, Director of Public Safety, also spoke in appreciation of the work done by the city's engineers. Papers and discussions were presented on the following subjects:

Water Waste Prevention—A paper by W. W. Brush, Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, New York City, described the work done under his direction in New York City since 1910, and especially during the extremely dry season of 1911, when the city was dangerously near a water famine. This paper gave the cost and results of house-to-house inspection and of pitometer surveys which have been regularly employed since 1911 to detect waste from leaky joints and broken mains. An interesting part of the paper was a brief description of an entirely new device for locating leaks in water mains, known as a "pulsograph," a description of which was given in our issue of Sept. 11.

In the discussion of Mr. Brush's paper the trend of opinion seemed to be that even after all the efforts to reduce consumption had been made and a saving of nearly one-third effected, a per capita consumption of 70 or 80 gal. per day was unnecessarily large, and that from the point of conservation and efficient administration, inspection work should be continued and made a regular establishment, notwithstanding the fact that the most pressing need of reducing consumption may have been alleviated by an additional supply. Attention was also called to the importance of making joints that would not leak as well as to detecting and repairing faulty ones. Mr. Brush stated that water mains with lead joints had been in service 50 years in Brooklyn without showing signs of leaking. Recent improvements in pipe joints were mentioned with which no leaks had occurred.

A paper by F. J. Hoxie, Engineer and Special Inspector, Associated Factory Mutual Fire Insurance Companies, Boston, Mass., on locating leaks in private factory fire services, described a method of introducing into the mains near the source of supply a solution of caustic soda or other alkali. The circulation of the water in the mains due to the leak distributes the alkali, and its absence or presence at various points where the water is drawn into a pail of water containing a solution of phe-

nolphthalein, gives, with the help of a water meter, the approximate location of the leak.

In the discussion following the reading of the paper, several interesting instances of finding large leaks in city water mains were cited. It was stated that the method used by Mr. Hoxie was not applicable to city service mains where there was a constant flow of water.

MAINTENANCE AND INSPECTION OF METERS—A. W. Cuddeback (Engineer and Superintendent, Passaic Water Co., Paterson, N. J.) read a paper on the effect of the condition of meters on revenue, an abstract of which appears on the opposite page. The discussion brought out many interesting points in regard to the use of meters by private water companies. The opinion of several speakers seemed to be that it was unquestionable that meters were essential to an economical and efficient operation of a plant for profit. In general it was stated that although the gross revenue was less than with a flat rate, the net revenue was greater, due to decreased operating expenses. Users of extraordinarily large quantities of water were found to get much larger amounts under the flat-rate system than they were justly entitled to. The necessity of keeping tab on the meters was generally recognized and several instances were mentioned where disk-type meters registered too fast—supposed to be an unusual failing in a water meter.

DESCRIPTIONS OF WATER-WORKS—Hiram A. Miller, Consulting Engineer, Boston, Mass., showed numerous lantern slides and gave an interesting description of an additional water-supply for Pittsfield, Mass. The work included the construction of a concrete dam about 100 ft. high, 600 ft. long, impounding 442,000,000 gal. of water.

The Philadelphia water-supply was briefly outlined by Carleton E. Davis, Chief Engineer of the Bureau of Water, and the operating methods and results of the Torresdale filter plant were given in a paper by Francis D. West, Chemist in charge. Mr. West's paper was discussed by Prof. George C. Whipple, of Harvard University, Consulting Engineer, New York City, who called attention to the inadequacy of filter-plant records when given in monthly and yearly averages, the need of full daily and even hourly records, and of the necessity of standardizing records so different plants could be compared. There was considerable discussion on various methods of cleaning filters and cost records for the Torresdale plant were read, which showed that cleaning by the Nichols machine (described in our issue of Sept. 30, 1909) was cheaper and more effective than any other method tried.

The new Catskill water-supply distribution system in New York City was described by Walter E. Spear, Department Engineer, Board of Water Supply. Many interesting lantern slides illustrated various stages of construction.

MORTALITY RATES AND WATER-SUPPLY—A paper prepared by John A. Vogelson, Chief of the Bureau of Health, Philadelphia, gave death rates from the principal diseases in Philadelphia from 1862 to the present time, with particular reference to typhoid fever and other diseases of the intestinal tract, which can in a large measure be traced to infected water and food supplies. The diagrams illustrating the statistics showed marked declines in the death ratese of all so called preventable diseases but none more marked than typhoid fever. The introduction of filtered water was followed by a marked decrease in deaths from typhoid fever (72 per 100,0[illegible] in 1906 to 12.5 in 1912). Subsequent outbreaks of typhoid fever were in almost every case traced to some defect in the water-supply or filtration system. It was stated in the discussion following that a similar study gave similar results at Wilmington, Del.

LOSS OF VELOCITY HEAD IN PIPE BENDS—In presenting a paper on this subject, Weston E. Fuller, Consulting Engineer, New York City, stated that he had no new theories to advance, but had merely attempted to show some definite conclusions as to previous experiments. The conclusions reached were that some experiments on large-sized pipes were essential to obtain accurate data, that the loss of head due to curvature was very much greater in large pipes than in small ones, and that the design of intake and other features of water-works plants calling for layouts of large-sized pipes required very careful study and special effort to avoid bends if the expected amount of water was to be delivered. The common allowance for loss of head due to curvature of one-quarter of the velocity head was found to be true only for comparatively small diameters, for 24-, 36-in., and larger pipe the loss was found to be greater.

WATER-HAMMER IN PIPES—At the closing session of the convention, John C. Trautwine, Jr., of Philadelphia, gave an impromptu account of the Russian experiments with water-hammer, with an explanation of the theory, upon which the new leak-detecting device called the pulsograph, described in Mr. Brush's paper, is based.

BUSINESS—The only business of importance transacted at the convention was the election of several new members and the passing of a resolution proposed by Prof. Whipple, to have a new committee of the association, composed of five members, which is to study ways and means of getting uniform and more complete records of filter-plant operation.

EXCURSIONS—An afternoon excursion was made by automobiles to various points of interest about the city, including the new high-pressure fire-service pumping station on Lehigh Avenue, where a demonstration was given of the efficiency of fire streams from a high-pressure hydrant compared with that of an ordinary steam fire engine.

An all-day excursion was made by steamer up the Delaware River to Bristol, where the pipe foundries of the Standard Cast Iron Pipe and Foundry Company were inspected. On the return trip stops were made at the Torresdale filtration plant, claimed to be the largest water filtration works in the world. About 200,000,000 gal. of water per day are now being filtered there. A stop was also made at the Lardner's Point pumping station, claimed to be the largest pumping plant in the world. Here twelve 20,000,000-gal. Holley vertical triple-expansion pumping engines are almost continually in operation.

Retaining Walls of Molten Slag were built a few years ago at the plant of the Butte Reduction Works, Butte, Mont. The forms were composed of cast-iron plates or panels, which were removed as soon as the slag had solidified. Culverts, reinforced with steel bars, were built in the same way. This unusual style of construction was designed by A. H. Wethey, now of New York, and was done to provide for a dump or fill of the tailings deposit from the concentrators, the culverts passing through the fill. The use of molten slag as a revetment for railway embankments along a river, to prevent erosion and sliding, was described in "Engineering News" of Jan. 30, 1913.

The Care and Maintenance of Meters and the Effect on Revenue*

By A. W. Cuddeback†

With the coming of government regulation of water rates through the public-utility commissions, and the basing of these rates by the commissions upon a valuation of the property, the need for careful and economical operation of water departments will be emphasized, and a careless, slipshod manner of doing business will be likely to land the water company or department in financial difficulties.

The flat rate or annual method of charging for water has its chief disadvantage in that there is no immediate individual penalty to follow the willful or careless waste of water; and the inevitable result is that a large percentage of the water delivered to a community under this system is wasted through leaky fixtures unless there is maintained an exceptionally efficient and constant inspection.

In order that meters may completely accomplish the desired results, it is necessary that they should be at all times in good condition and adjusted to the work they are to perform; in other words, measure accurately all of the water entering the premises.

The determination of the type and size of meter for the ordinary domestic service is not difficult, but in a water system of any size there are many services that require some study to determine the proper meter to secure the best results. In large factories the use of water may be so varied that no single service can be equipped with a simple meter to satisfactorily and accurately measure all of the water. The interests of the consumer and the water department are sometimes antagonistic in these cases; the consumer demands a large, full flow at times, while at other times only a small flow is demanded, and in many cases a fire-protection service is also expected from the same source.

It is obvious that the water department cannot hope to satisfy all of these demands, and still economically and efficiently as well, measure the water through one instrument.

The dishonest water user who will tamper with the meter (for there are a few of these in every community) is not the enemy to cause the most worry, although he needs attention, and the various ways by which he can affect the registration of the meter should be known to the wide-awake meter-man. The condition of the ordinary service meter should be carefully watched, and to do this intelligently and effectively requires not only experience and a knowledge of the character of the service to which attached, but careful, continuous, and painstaking work on the part of the man responsible for the condition of the meters.

Meter Reading Records—The readings of the meters are taken on loose-leaf slips, which always have on them at least a year's record of the consumption at that particular property, and on an average the record for a much longer period. On the back of this slip is noted the character of the property supplied; a record of the number of families; important fixtures, business, etc., any information that may be useful to the meter superintendent in helping him to arrive at an instant conclusion as to whether the meter is performing its work or not.

It is aimed to maintain not only accuracy, but a sensitiveness close enough to measure the innumerable small leaks that occur in plumbing fixtures, and to do this requires unceasing and careful study of the various conditions under which the meters are operating, and it follows that close watch of their work while in service must be given by an efficient man to insure a reasonably full registration of the water.

A falling off or an increase in the quantity of water registered by a certain property immediately calls for an explanation. Oftentimes the explanation is found on the slip. If the meter reader has been properly instructed and is conscientiously doing his part of the work, he has already noted the change in consumption and made inquiries or tests to determine the reason.

No attempt is made on the first or regular reading to ascertain the accuracy of the meter, as too much time is required, and the routes would come in unfinished, each route being made up on an average of 120 readings, which is considered a good day's work. The aquaphone, however, must be used in every instance on the first reading. This is an invaluable accessory to the meter department.

Each inspector is required at all times to carry one and after a reading of the meter is taken, contact is made to the meter or pipe near the meter to determine whether any water is passing that is not being registered. The record of this observation is indicated directly to the left of the reading by simply an "S" for still, "L" for leak, and "R" for running. In all cases the record slips marked "L" and "R," where the quantity is not above normal, and all other records of doubtful quantities, are laid out for verification of readings and thorough investigation.

On these "back calls" the aquaphone is again very useful in determining definitely whether an actual leakage exists without first inspecting all the plumbing. Time can be taken on these second calls to determine whether the "L" noted on the first reading was due to the final filling of a closet tank or an actual leak.

Should there be a leak, the meter is timed for 0.1 cu. ft., if it is sensitive enough to record it, and if not, it is so stated on the inspection blank, and the meter is promptly taken out. In either case an inspection is made and the leak located.

It is not uncommon also for the inspectors to report a leak which they estimate the meter is not fully registering.

Where no leaks exist and the consumption is below normal, the meter is tested out for sensitiveness by attaching an orifice to a hose bibb or faucet. This orifice passes a stream approximately equivalent to the average closet leak, allowance being made for difference in pressure of the various sections; the time required to register one-tenth of a foot, or the fact that the meter failed to record it, are all noted on the slip directly opposite the reading.

All meters that will not register the average closet leak, or 300 gal. per 24 hours, are marked by the inspector for the attention of the superintendent, as we are satisfied that such small flows go to make up a large part of the total consumption.

*Abstract of a paper read before the New England Water Works Association, Philadelphia, Penn., Sept. 10, 1913.

†Superintendent and Engineer, Passaic Water Co., Paterson, N. J.

During the meter-reading period, the slips are turned in daily, and are examined carefully by the meter superintendent, and the subtractions checked in ink. The meter superintendent makes a list for further examination and test in the field, and finally, from all the information turned in by the inspectors, the performance of the meter as indicated by the registration, and from his knowledge of the character of the property served by the meter, he determines at each reading the meters to be removed for test.

This list is turned over to the plumbers or meter repair men for immediate attention as soon as a district is gone over, so that the removal of doubtful meters is going on continuously. After the reading and inspection, property owners are notified by postal of high consumption, and if the inspection shows the trouble, this is called to his attention.

In this way not only are the bad meters removed promptly, but property owners are as promptly informed of leaks which cause waste and high bills.

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American Public Health Association Papers

Recent Progress in Methods and Character of Street Cleaning*

By S. Whinery†

There has been no radical or particularly notable advancement during the last few years in the machinery and methods of street cleaning in American cities. But no little progress has been made in improvements upon methods and appliances that have become standard, and their more efficient and economical use, in complying with the public demand for cleaner streets than had heretofore been tolerated, and in a more careful study and analysis of the business, especially with reference to detailed cost of the work, for the purpose of effecting economies.

MACHINERY AND APPLIANCES—The flood of patents issued for street-cleaning devices continues unabated, but these patents relate largely to details and disclose little of value for practical use. This is somewhat surprising in this land of inventors. Most of our street-cleaning apparatus is admitted to be more or less crude and unsatisfactory, and there would seem to be possibilities for material improvements, if not radical innovations. The applications of mechanical power in the place of horse power to street-cleaning work has received attention and has been tried in a number of cities, but the results do not seem to have sufficiently commended themselves to municipal officials to warrant their more general use at present.

The application of the vacuum or suction principle to the picking-up and collection of street dirt is also being experimented with to a small extent. Such machines, if they can be perfected so as to do the work satisfactorily and economically, would have the great advantage of removing the dust from the street without resort to the use of large quantities of water, which is a consideration of importance where water is scarce or high in cost.

THOROUGHNESS AND EFFICIENCY—There has been in the past few years a decided advance in the standards of cleanliness of streets demanded by the public and attained by the municipal authorities. This is noticeable both in the large and in the smaller cities of the country.

In towns and the smaller cities, and the surburban section of the larger cities, where earth and broken-stone street surfaces prevail, the use of oil to suppress dust has greatly increased, and is now quite general. While this is not, strictly speaking, a street-cleaning process, it serves as an effective improvement in the comfort of using such streets, and eliminates the sanitary danger, and the inconvenience and damage from flying dust.

ACCOUNTING AND ANALYSIS OF COST—Perhaps the most promising and fruitful advance that has been made in recent years is the greater attention given to the study of the details of street cleaning and the keeping and analysis of more complete and itemized accounts. In an increasing number of cities the accounts of the street-cleaning department have been revolutionized and expanded so that the total and unit cost of every important detail of the work may be ascertained and analyzed. This requires, of course, greater attention to the collection of exact data of quantities and costs, and involves no little additional expense, but it is becoming more and more appreciated that the money so spent is wisely invested, since the main reliance for increased efficiency and economy in this, as in most other lines of business, must be upon small savings in many details rather than upon any radical changes in methods and machinery.

The value of the results of practice and experience in other cities for comparative study is becoming more appreciated, and there is, therefore, growing up a strong demand for the general adoption of a uniform system of accounting, and for more complete and detailed printed reports of street-cleaning departments.

SOME PROBLEMS THAT ARE RECEIVING ATTENTION—Some of the important matters that have more recently, and are now receiving increased attention may be mentioned:

One considerable source of the dirt and waste that must be removed from the streets is commonly called street litter, consisting of miscellaneous wastes thrown upon the streets and sidewalks by those passing along the streets, or swept out of business houses and residences. Street littering is effectively prevented in most European cities by the rigorous enforcement of laws or ordinances prohibiting it. Most of our American cities have such laws and ordinances, but they are practically "dead letters."

The possible utilization of street sweepings in some way that will partly repay the cost of street cleaning is another matter that is receiving more attention than heretofore. The most promising outlook for such utilization lies in the direction of filling low lands, or building up new and very valuable areas of land by filling in shore areas now covered by shallow water and at present not useful for any purpose. Contrary to the prevailing opinion, experience and investigation have shown that street cleanings free from garbage may, if properly handled in the dumps, be so used without danger to the public health and without serious inconvenience or offense to the public.

Street sweepings from paved streets contain very considerable quantities of valuable fertilizing elements, the value of which at the market prices of these elements, probably averages at least two dollars ($2) per ton of sweepings. The cost of transporting and handling the raw sweepings is usually too great to permit of their profitable use as fertilizers in the farming districts, but some satisfactory method ought to be and probably will some time be discovered to profitably recover these fertilizing elements.*

Attention is being urged in many cities toward preventing the large accumulation of dirt and débris, and the inconvenience and expense to street-cleaning department, caused by building operations. Custom seems to have given builders the idea that they have a right to deposit the waste from their operations upon the fronting streets and that it is the duty of the street-cleaning department to remove and care for it. A number of cities have taken suitable action in this matter and others will doubtless follow.

*Condensation of a paper presented before the Sanitary Engineering Section of the American Public Health Association, at Colorado Springs, September, 1913.

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The Prevention of the Corrosion of Iron Water Mains

Within the past ten years much trouble has been experienced with the "red water plague" as a result of the corrosion of water pipe used in water-works systems. At the annual meeting of the American Public Health Association at Colorado Springs, Colo., Sept. 10 to 13, a paper entitled "Prevention of Iron Corrosion" was presented to the Sanitary Engineering Section by W. F.

*A note on the sale of manure at Cleveland, O., at $1.50 a ton appeared on p. 525 of our issue of Sept. 11, 1913.—Ed.

Montfort, chemist of the St. Louis Water-Works, St. Louis, Mo. After reviewing some of the literature of the subject (see references at the end of this article) and quoting Weston (7) to the effect that "most of the increased corrosion of pipes ascribed to filtered water is due to the withdrawal of organic matter which would form a protective coating" on the interior of the pipes, Mr. Montfort proceeds with his own views, as follows:

This acceleration [referring to the words quoted just above.—Ed.] of corrosion follows not only coagulation and mechanical filtration, where the effect might be attributed to the increase in carbon dioxide and the greater conductivity of water treated with a coagulant; the effect is noted, though in less degree, after filtration through sand, without coagulant. The organic matter which is protective for any reason is most readily removed by filtration; the residual matter, whether originally different in character is different in its behavior when left alone. There is room for discrimination in the varieties of organic matter in colored waters, before the whole question of corrosion can be understood.

The discrimination which is made in regard to the behavior of colored waters during coagulation is suggestive. It is a matter of common experience among operators where coagulation of colored waters is practiced, that generally a certain proportion of the coloring matter is removed with ease; that when color is higher a proportionate increase in the charge of alum is not followed by corresponding effectiveness; that in some cases of moderately high color, addition of alum gives no visible floc though the alkalinity present is sufficient to react with the full dose of alum used.

Oxidation of freshly prepared leaf extract by potassium permanganate is difficult, although readily carried to completion after some months' standing. The determination of oxygen consumed in colored waters from the Upper Mississippi drainage area is sometimes very slow, requiring unusually prolonged digestion for complete color reduction. There seems to be a residuum of organic matter not readily attacked by oxidizing agents until after months of exposure to air and light at ordinary temperatures.

It has occurred where iron sulphate and lime were used in treatment of such a water, having a color of 90, with the addition of lime to produce a caustic reaction (alkalinity toward phenolphtalein, 62, total, 116), a color of 35 parts per million persisted, and 2 to 3 parts per million of iron remained in solution. When this water was heated to about 150°, as in hot-water pipes, there was developed the red color of ferric hydroxide. In this case the precipitation of iron by an excess of hydroxyl was incomplete at ordinary temperatures, and only prolonged digestion with dissolved air served to remove it from solution.

The failure of alum to give a precipitate with abundant alkalinity, and of ferrous sulphate in the presence of hydroxyl ions, suggests the formation of complexes like those little ionizable alcoholates with metal ions, formed by citrates, tartrates, sugars, and the like, which necessitate special procedure in analytical determination of iron and aluminum.

Glucosides freshly derived from vegetable tissues (13) suggest themselves as the possible agency in this retarding action, while their decomposition products yield readily to oxidation with chemicals or assist in furnishing the protective matter which accumulates with organisms in the slimy coating of old pipes as well as on sand grains of filters.

It would be interesting to have experimental results on precipitation of iron ions with increasing hydroxyl concentrations in some of the most studied "red water plague" spots, to ascertain whether there is not some organic matter present which acts in a similar manner, holding in cold solution considerable quantities of iron, which are released on digestion with dissolved oxygen under conditions like those in hot-water pipes.

It may be that the development of some method of speedily ripening coloring matter for immediate removal is prerequisite to the theoretically easy prevention of corrosion proposed by Whitney (1). In cases where this ripening has already been accomplished, as in the instance cited by Mr. Ledoux (8), the prevention of red water appears simple, though accomplished at a considerable increase in hardness. In other instances, it may appear that aëration for partial removal of carbon dioxide will sufficiently prepare a water for color removal and the inhibition of corrosive action. There are doubtless others which will be better met with another treatment.

The removal of color from a relatvely hard water, containing much magnesium, is well accomplished to the extent that magnesium carbonate is precipitated. It is at an early stage in the progressive addition of lime water that the greatest color removal occurs. Addition of magnesium chloride or sulphate and precipitation of large volumes of magnesium hydroxide in soft colored waters is not productive of the same degree of color reduction.

The success of the magnesite used by the Candy Filter Co. in English practice suggests the propriety of appeal to this reagent as better adapted for the removal of color from very soft waters. The question of the occurrence of magnesium carbonate in chalk so commonly used in treatment of soft English waters may be fairly raised, and as a possible explanation of the success of chalk treatment and the general failure of the use of lime alluded to by Mr. Thresh in his discussion of Mr. Whipple's latest paper (12).

SUMMARY—The purpose of this paper is to emphasize the intimate relation between certain reactions of organic matter, and the varied behavior of coloring matters in natural waters, which have served to protect or to increase the corrosion of metals in water.

Corrosion in many cases is associated with highly colored waters. Some apparently conflicting evidence is cited as to the effect of lime treatment on colored waters. Organic matter may be either protective or corrosive.

A discrimination is made in the behavior of organic (coloring) matter with coagulants, and a suggestion offered as to the possible cause of some cases of red water in hot-water systems, from the breaking down of complex alcoholates with metal ions.

The question is raised as to the development of color removal methods as prerequisite to a complete cure of some local occurrences of red water.

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Studies in Air Washing*

By George C. Whipple† and Melville C. Whipple‡

Clean air in motion and of proper temperature and humidity is necessary to indoor comfort. This is, perhaps, as succinct a statement as can be made of atmospheric requirements according to modern views.

We do not yet know the best combination of indoor temperature and humidity for our greatest bodily comfort and efficiency.

We do know, however, as a matter of universal experience, that it is uncomfortable to remain in air that is still, or as we say that is "dead." Another thing that we need to appreciate is that the air that we breathe should be clean. So anxious have we been in the past to make sure that the carbonic acid did not exceed some illogical, arbitrary standard that we have overlooked this most patent and obvious need. A clean water-supply is now a watchword of our modern cities. If precedent is followed we shall come to regard as undesirable much of the air that would not by present-day standards be called unclean, as well as air that is grossly laden with dust and foul gases.

Modern cities are dust producers. Streets and pavements and even sidewalks are worn by friction of the traffic, especially in this age of the railroad and automobile; car wheels are ground to metallic dust; fabrics turn to lint; fuel burns with products of smoke and ashes. Dust is being continually produced both within and without our factories and houses.

Air contains more dust near the street level than at higher elevations. Tests made on May 13, 1913, at the South Terminal Station, Boston, where air is taken in at the roof, showed lower dust counts than air taken at the street level at various office buildings in the business district of Boston. Tests made at the John Hancock building on June 6, 1913, showed that at the street level the air contained 483,000 dust particles per cu.ft.; at the 5th story there were 233,000; and at the 10th story, 140,000 per cu.ft. Tests made on July 2, 1913, in New York at the Metropolitan Life Insurance Build-

*Condensed from a paper read before the Sanitary Engineering Section of the American Public Health Association, Colorado Springs, Colo., September, 1913.

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ing and the Woolworth Building, the last named being the highest building in the world, showed similar reductions in the amount of dust in the air in the upper stories. For example, at the Woolworth Building the air at the street level contained 221,000 dust particles per cu.ft.; at the 10th story there were 85,000, at the 30th story 70,000, and at the 57th story 27,300. The dust counts at the Metropolitan Building were somewhat lower than at the Wolworth Building, the number at the street level being 173,000, and at the 50th story 21,000 per cu.ft. The lower counts at the Metropolitan Life Building may possibly have been due to the fact that this building is situated near Madison Square and is more isolated than the Woolworth Building which is located down town in a more crowded section. Both sets of observations were made on warm quiet days.

Winslow has shown that the air of many of the New York schools contains even larger numbers of dust particles than those above mentioned, ranging from 400,000 to 1,000,000 per cubic foot. Studies by the authors at the gymnasium of the International Y. M. C. A. College at Springfield, Mass., have likewise shown that the indoor air contains dust particles in numbers usually more than 100,000 and sometimes even 400,000 per cubic foot. Such results are naturally to be expected, for indoor air is merely the outer air drawn in through the ventilating ducts, the inlets to which are often badly located, while to this outer air is added the dust resulting from friction and air movement of various kinds indoors.

Unclean air contains bacteria and other living organisms as well as lifeless dust particles. The bacteria are usually much less numerous than the dust particles. Our investigations at the John Hancock Building show that at the street level the air contained 1330 bacteria per cu.ft. capable of developing on gelatin at 20° in 96 hours, while at the 10th story the air contained 330 per cu.ft. Speaking broadly it was found that there were from 200 to 300 times as many particles of dust as bacteria. The bacteria capable of growing at the temperature of the human body were still less numerous, there being only 30 such bacteria per cu.ft. found at the street level and 17 at the 10th story. The sample from the 3rd story, however, contained 83 per cu.ft., evidently an erratic observation. No attempt was made to determine the particular species of bacteria in these samples, but tests were made for the presence of B. coli and only once was this organism found, namely, in the sample collected at the 3rd story. Molds were also present to the extent of 20 per cu.ft. at the street level and 3 at the 10th story.

There is no expression more common than that of "fresh air." Just what is meant by this term? It certainly does not involve the factor of air temperature to any extent, for we use the expression both in winter and in summer, and at times when the outside and indoor temperatures are the same. Neither does it involve humidity. In the opinion of the writers it may be regarded as practically synonymous with clean air in motion, air that is free from dust, from bacteria, and from malodorous or offensive organic emanations and poisonous substances.

The effect of forcing unclean air into buildings is to nullify the result aimed at by ventilation, that is to provide a supply of fresh air. The presence of dust, bacteria and odors not only renders the conditions uncomfortable and deleterious to health but it results in attempts at window ventilation, and this means poor ventilation, unequal heat distribution and draughts.

Supplying buildings with unclean air may often be obviated by a judicious choice of location for the inlet duct. A change of location from near the street to some higher point, or from one side of a building to another may greatly improve the quality of the influent air.

Crowded buildings and dusty city streets will often render it impossible to secure clean air from the outdoor atmosphere, without resorting to artificial purification. Fortunately this purification can be accomplished. Just as unclean water may be made wholesome by the employment of Nature's process of filtration, so can unclean air be purified by the application of another efficient process of Nature, air-washing. The purifying effect upon atmospheric air of a heavy fall of rain is well known. A shower is said to freshen the air. Not only are suspended particles removed, such as dust and bacteria, but gaseous impurities, such as acids and ammoniacal vapors, are dissolved and removed, leaving the air sweet and clean. A determination of dust particles in the air after a heavy rain at Harvard University showed only 25,000 particles per cu.ft., whereas in dusty weather the numbers would have been measured by hundreds of thousand. This figure compares favorably with a determination made over the water of Long Island Sound at a point several miles from the shore, when the air contained 18,000 dust particles per cu.ft.

To ascertain the efficiency of air-washing as a means of purification the authors made a study of this method as carried on at several buildings in Boston and Springfield, Mass.

The process of air washing consists of passing the air horizontally through a chamber in which water is falling in drops, as rain, or into which it is sprayed. The sprays are obtained by forcing the water out of perforated pipes or through nozzles placed across the ducts. When the sprays intersect they are said to form a curtain. The object is to bring the air and water into intimate contact. Besides the washing chamber there are heating or tempering coils in the ducts or in a separate chamber, and devices for controlling temperature, a primary object of air washing in the past having been that of conditioning the air with respect to its temperature and humidity. The water used for washing is circulated by means of a pump so that it may be used over and over in the spray chamber for a considerable time. If desired this water may be cooled so as to influence the temperature of the air. Several forms of air washers are on the market, essentially similar in principle but differing in details of construction.

Although it has been known that air washers tended to clean the air, and they have sometimes been introduced for that very purpose, their efficiency as a means of air purification has not been determined. Accordingly the authors undertook a few preliminary studies in order to get data to serve as a guide in planning a more complete investigation. These studies were made at certain installations in [the business district of] Boston and Springfield, where washers made by different companies are in use and included chemical and bacteriological analysis of the air before and after washing, and analyses of the water before its use and after different periods of use. At Springfield the studies formed a part of a more extensive series of ventilation studies made at the gymnasium of the International Y. M. C. A. College during the winter and spring months. [The results of the Boston studies are shown in the accompanying table. Various other tables of analyses given in the original paper are omitted here.—Ed.]

TABLE SHOWING REMOVAL OF BACTERIA AND DUST PARTICLES FROM AIR BY VARIOUS AIR WASHERS, BOSTON, MASS.

Source of sample of air	Date 1913	Bacteria per cubic foot: Gelatin @ 20° Number	Gelatin @ 20° Per cent. removal	Litmus agar @38° Number	Litmus agar @38° Per cent. removal	Molds per cu.ft. (gelatin)	Dust particles per cubic foot: Number	Per cent. removal
Washer A								
Outside	Feb. 3	10		0		10	229,600	
Washed	"	5	50	0	.....	0	30,500	87
Outside	Feb. 10	110		0		8	111,100	
Washed	"	13	88	0	.....	3	58,000	48
Outside	May 13	1000		7		20	178,300	
Washed	"	300	66	7	0	7	124,700	30
Washer B								
Outside	Feb. 1	27		17		10	158,300	
Washed	"	17	37	7	55	3	71,300	55
Washer C								
Outside	Mar. 13	13		3		0	248,000	
Washed	"	3	77	0	100	0	72,000	71
Washer D								
Outside	Mar. 13	57		3		13	241,000	
Washed	"	7	88	3	0	3	104,000	57
Washer E								
Outside	May 1	187		20		20	729,300	
Washed	"	110	41	7	65	13	531,000	27

The washers were supplied with air taken from inlets placed as follows:

Washer	Position of Inlet
A.	8th story on the roof.
B.	Above street entrance.
C.	Second story, back side of the building.
D.	Street level, just above sidewalk.
E.	Street level, just above sidewalk.

The analyses of air and water were made by the standard method of the American Public Health Association supplemented by the use of special apparatus.

Comparison of the dust counts in the air before and after passing through the water showed that in the case of the five Boston washers the percentage removal ranged from 27% to 87% and averaged 54%, while the removal of bacteria ranged from 37% to 88% and averaged 64%. Generalizing from the data given in the table it is fair to say that the air washing process as practiced removed about two-thirds of the suspended particles—including dust, bacteria and molds.

When street air was passed through a washer it required but a few hours for the water used to resemble sewage in appearance and analysis.

The gymnasium of the International Y. M. C. A. College at Springfield afforded an opportunity of studying a new phase of the problem of air washing, namely that of purifying air that had passed through an occupied room. It was supplied with air from a ventilating plant provided with an air washer operated at such a rate that the air in the room

was changed every 9 to 12 minutes. This plant was well adapted for experiment for the reason that air could be taken in from the outside and washed, or the exhaust air from the room could be returned through the washer and again forced into the gymnasium. Comparison could thus be made between the use of outside air and of rewashed air. As in the Boston experiments analyses were made of the air before and after washing and of the water after different periods of service. Frequent tests were made under different conditions of operation.

When the exhaust air left the gymnasium it had a noticeably sour and musty odor. After passing through the washer this was almost completely removed and the returned air was fresh and sweet. At the same time the "gymnasium odor" was acquired by the washer water and could be easily detected in the sample bottles. The washer water was also found to contain large numbers of bacteria and many epithelial scales derived from the skin of the men exercising on the floor. Dust, bacteria, molds, nitrogen, and iron were removed from the indoor air by the washer at Springfield to about the same extent as by the washers tested in Boston. The results indicated that under the conditions there existing the exhaust air could be washed and returned to the gymnasium with entire safety and comfort to the occupants of the room and with no apparent sacrifice of wholesome properties. The carbonic acid was not reduced by the air washer—and theoretically it ought not to be reduced—but this fact did not at all affect the acceptability of the washed air to the occupants. The details of these experiments are described in the "American Physical Education Review," September, 1913. Generalizing from these results, it may be said that the recirculated air after washing was cleaner than unwashed outdoor air but was slightly less clean than the outdoor air after washing.

The advantage of washing and recirculating the air lies in the great saving of heat in cold weather. D. D. Kimball, who designed the ventilating plant at Springfield, estimated that when the outdoor temperature was 32° F. the saving in cost of operation effected by recirculating washed air was 40%, while with an outdoor temperature of 0° F., the saving was 50%. The use of less coal at Springfield when the air was being recirculated instead of being drawn in from outdoors was plainly evident and was commented upon by the engineer in charge of the Springfield plant. In the summer the washer may be operated as a cooling plant to keep down the temperature of the indoor air—or with the windows open it may be shut down to save expense.

The common standard of 30 cu.ft. of air per capita per minute, which is now generally applied to schoolhouses, was based upon the idea of keeping the carbonic acid down to a fixed amount. When it became recognized a few years ago that carbonic acid was a negligible factor, some made the inference that a smaller volume of air would suffice. They failed to consider that circulation of the air is of itself one of the essential elements of indoor comfort and a necessary feature of good ventilation.

The cost of heating large volumes of cold air has naturally stood in the way of efficient ventilation of schools and factories during the cold weather. Another difficulty has been the low indoor relative humidity produced by heating outdoor winter air to a comfortable room temperature. If, therefore, both of these objections can be overcome by washing air and using it over and over, so as to furnish an ample supply of clean air in motion, the method is one that has much to commend it. Naturally there would be a limit to the continued use of the same air, but ordinary leakage and the possible use of a small percentage of outside air would prevent the concentration of any substances not removed by the washer.

Our study of the subject of air washing has led us to believe that it is one of the vital elements of ventilation in localities where it is difficult to obtain a supply of clean air, and that the recirculation of air thus washed is deserving of serious consideration from the standpoint of economy. It is very evident that the air washers now in operation are not giving as high a degree of efficiency as might be obtained with better designs and more skillful operation and the details of the process should be submitted to careful scientific research.

The Development of Water Power in the National Forests

The accompanying table shows the status of water-power developments in national forest reserves, on June 30, 1913. The figures are condensed from a much more detailed compilation made by T. W. Norcross, assistant chief engineer of the U. S. Forest Service, Washington. D. C. It has seen that out of a total of 783,600 hp. in developments approved, 660,000 hp., or over 84%, is on the Pacific coast. It also should be noted that the government estimates of horsepower capacity have been based on minimum stream flow under original conditions and that, because of storage works which have been constructed to equalize the flow, the actual plant capacity installed might amount to twice the government figures.

PERMITS FOR WATER-POWER DEVELOPMENT IN NATIONAL FORESTS, IN FORCE JUNE 30, 1913

	—District 1—			—District 2—			—District 3—			—District 4—			—District 5—			—District 6—			—All districts—		
	Transmission Line permits	Power permits	Horsepower Capacity	Transmission Line permits	Power permits	Horsepower Capacity	Transmission Line permits	Power permits	Horsepower Capacity	Transmission Line permits	Power permits	Horsepower Capacity	Transmission Line permits	Power permits	Horsepower Capacity	Transmission Line permits	Power permits	Horsepower Capacity	Transmission Line permits	Power permits	Horsepower Capacity
Projects Constructed or operating	11	5	17,300	20	22	9,400	3	1	3,300	3	12	3200	34	23*	66,400	8	13	11,600	79	76	111,200
Construction Started, not operating		9	13,700		3	1,900				1			3	11	55,800		6	51,100	4	29	122,500
Construction Not started	2	6	25,400	—	11	25,600	1	3	18,000	1	10	4600	8	24	390,400	1	16	85,900	13	70	549,900
Total	13	20	56,400	20	36	36,900	4	4	21,300	5	22	7800	45	58	512,600	9	35	148,600	96	175	783,600

* Including a grant to the Southern California Edison Co. by Act of Congress, May 1, 1906.

The Forest Service districts shown in the table comprise territory as follows: District 1, Montana, North Dakota and northern Idaho; District 2, Wyoming, Colorado, Kansas, South Dakota, Nebraska, Minnesota, Wisconsin and Michigan; District 3, Arizona, New Mexico, Oklahoma, Arkansas, Florida and Porto Rico; District 4, most of Nevada, Utah, southern Idaho and western Wyoming; District 5, California, and a narrow strip in western Nevada; District 6, Washington, Oregon and Alaska.

The Art of City Planning is a monopoly of the architectural profession according to the accredited representatives of that profession in Australia. At the time of the recent competition for the design of the new Australian capital city, the government appointed as an examining board an engineer, a licensed surveyor and architect. This aroused the Royal Victorian Institute of Architects to a protest that only architects should be included on the examining board and, on the refusal of the government to change the appointment, both the local body of architects and the Royal British Institution of Architects advised its members to refrain from competing.

The ignorance on which such a stand is based is well shown by the following extract from the architects' protest.

. . . the contour plan being already made we claim that all the ground is now prepared for the advent of the Architect [Capital A.—Ed. "Eng. News."]—the only man competent to deal with the aesthetic problems of laying out a city.

It should be understood that the competition was for the design of an entire city, including such essentially engineering elements as water-supply, river control, street layout, etc.

Another Dust Explosion at Buffalo, N. Y.

A dust explosion wrecked, and the fire which followed further damaged the plant of the Clover Leaf Milling Co., Buffalo, N. Y., September 13. The plant parallels the tracks of the Pennsylvania R.R. and consists of a main brick building four stories in height, flanked on two sides with one-story brick storage sheds or warehouses. The office of the concern adjoins the northerly warehouse. At the time of the explosion the bins contained about eighty cars of grain. Three explosions occurred in rapid succession, and as the walls collapsed there was an outburst of flames which seemed to envelop the entire building.

According to the officers of the company and the mill foreman, bits of grit and other substances escaped the sifter or screen and dropped into the mill proper, where they were crushed between the rapidly turning wheels. Resulting sparks set fire to the fine particles floating throughout the mill room.

The mills had started work at 2:30 a.m. and had been running about fifteen minutes when the first explosion took place. There were about 30 men at work at the time, a few on the top floors, the rest on the ground floor; during normal operation the concern employs about 100 men. At the time of the arrival of the firemen the mill was in flames and so rapid was the spread of the fire that before the second and third companies of firemen could get their apparatus into action, the roof and top floors collapsed. The grain was ruined.

Six men were injured, one probably fatally; the other five recovered. The disaster closely resembles the explosion at the Husted Mills in Buffalo, June 24, 1913 (ENG. NEWS issues of July 3 and 10, 1913), although the results were less serious. The company had recently installed new ventilators and safety devices as a precaution against dust explosions.

The company estimates its loss at between $150,000 and $200,000.

A Stand Collapsed at Guadeloupe, French West Indies, Sept. 7. The stand contained 600 persons at the time, who were watching an aëroplane flight; about 20 persons were injured.

Two Buildings Collapsed on Sept. 5: the first was a tobacco warehouse at Farmville, N. C., where two persons were killed and seven injured; the second was a three-story structure at Camden, N. J.; four workmen were injured.

A Guard Rail Broke, on the starboard side aft of the Ellis Island ferryboat, in New York Harbor, Sept. 9, dropping four men into the water; one of them died from shock, the other three were rescued. This rail was weakened in a collision with an excursion boat two weeks ago, but was supposed to have been repaired to its original strength.

A Forest Fire which probably would have destroyed a large power plant in the western part of Montana, was prevened by the prompt action of the engineers who are surveying the new line of the proposed Butte & Wisdom R.R., in the Big Hole Valley. The fire-line method for opposing the flames was employed; a swath around a square mile of timber land was cut, and the fire thus prevented from spreading. The efforts of the engineers were further strengthened by the aid of the nearest forest ranger, who speedily appeared on the scene.

The Validity of the Luten Patents on concrete bridge construction is to be tested in the Federal court at Des Moines, Iowa. Suit was brought in this court for infringement against the Marsh Engineering Co. Under a law enacted by the last Iowa legislature the State of Iowa has intervened as a party in the suit, and through the Attorney-General of the State has undertaken its defense. The law in question empowers the Attorney-General, by direction of the Governor, to undertake the defense of any suit brought against any county, town or city, or officer thereof, or contractor thereof, on account of any patent relating to highway or culvert construction.

Car-Float Service on the Chicago River is to be operated by the Erie R.R. to facilitate its local freight service. There will be three stations for receiving and delivering freight, two of which will be for both carload and less-than-carload (or package freight) while the third is for carload freight only. Freight will also be delivered direct to consignees having wharf and landing facilities. There is already in operation on the river a service of steam and gasoline lighters, serving some of the large wholesale houses and other shippers and local freight stations. As yet this use of the river for local freight service is of only limited extent, but it seems likely to be increased in the future.

A Union Station and Joint Railway Approach are proposed at Hamilton, Ont., as a relief from the present condition of several separate lines across the city. The city authorities have been agitating for this improvement, partly on account of the growing necessity for the elimination of the numerous grade crossings, and the desirability of concentrating the railway facilities along the north side of the city. Plans have been prepared also for elevating and depressing present tracks along the south side. The cost of this latter work is estimated at $760,000 for track elevation, and $1,200,000 and $2,940,000 for two different plans for track depression. The question has been submitted by the city to the railway companies and the Dominion Railway Commission. The above particulars are taken from an article in the "Canadian Engineer," by E. H. Darling.

Safety at Sea is the object of the committee of experts just appointed by the Department of Commerce, to investigate the bulkhead subdivision of hulls and other structural features affecting the safety of ships at sea.

The committee is made up of Washington L. Capps, Chief Constructor of the Navy, David W. Taylor, Naval Constructor, George Uhler, Supervising Inspector General of the Steamboat Inspection Service, and E. T. Chamberlain, Commissioner of Navigation.

The committee is coöperating with James Donnelly, Naval Architect, of Boston, representing a committee of Atlantic Coast shipbuilders. The Department of Commerce has issued a circular inviting suggestions from experts, with reference to 14 designated questions as to details of vessel construction and equipment affecting safety. Copies of the circular may be obtained by those interested on application to the Department.

A Historic Gavel of unusual composite construction has been made by the Philadelphia section of the Illuminating Engineering Society for first use at the Pittsburgh convention of the society, Sept. 22, 1913. It is intended to represent various stages of development in artificial illumination in this country. The head band is a handle from an old candle mold; inserted in the head are two pieces of iron from one of Franklin's oil-torch brackets, one of Edison's early paper-filament lamp dies, a piece of the first Edison three-wire cable laid in Philadelphia, a piece of a single-conductor arc-light cable laid in Philadelphia in 1890, a fragment from an early gas holder in Baltimore, an electrode from Steinmetz's first magnetite arc lamp, and piece of an electrode from a Moore vacuum tube exhibited in 1896. In the end of the handle a cavity holds a vial of Welsbach's original mantle-impregnating fluid, exposed to view by windows and held in by a plug of wax from a standard candle. The handle is tipped by a carbon holder from an early Thomson-Houston arc lamp.

The Proposed Gravity Water-Supply for Winnipeg, Man., mentioned in our issue of June 19, 1913, p. 1301, as being under investigation by Rudolph Hering and James Fuertes, of New York City, and Frederick P. Stearns, of Boston, has been favorably reported on by those engineers. The project involves bring water from Shoal Lake, 95 miles, at an estimated cost of a little over $13,000,000. The city council unanimously voted the necessary appropriation for the project, on Sept. 8, and referred it for endorsement by the voters on Oct. 1. It is expected that the project will be ratified. If so, surveys and plans will be made at once, and contracts will probably be let during the coming winter. T. R. Deacon, mayor of Winnipeg, to whom we are indebted for the foregoing information, informs us that September, October and November are the best months of the year to examine the pipe-line route, and therefore it would be well for

prospective bidders to improve the opportunity instead of waiting until winter sets in, when the country will be difficult of access. The conduit will be of concrete for about 85 miles, with reinforcement in some sections. This portion will have a daily capacity of 85,000,000 Imp. gal. (102,000,000 U. S. gal.). From the end of the concrete portion, at the site of a reservoir proposed for construction later on, 5-ft. steel pipe and beyond that 4-ft. cast-iron pipe will lead into the city. The aqueduct will serve a few small municipalities besides Winnipeg, lately formed into the Greater Winnipeg Water District.

Dry Excavation in the Culebra Cut at Panama was completed on Sept. 7, eight days ahead of the schedule as announced, as follows, in the Aug. 27 issue of the "Canal Record":

All steam-shovel operations in Culebra Cut proper will be discontinued on Sept. 15, and between that date and Oct. 5, when water will be admitted, all equipments and other material to be recovered, including over 36 miles of track, must be taken out of the cut. At the present time, about 30 shovels are at work in the cut. All the bottom material remaining after Sept. 15 will be drilled and blasted preparatory to its removal by dredges.

On Aug. 1, 998,900 cu.yd. remained to be removed from inside of the theoretical canal prism. It is estimated that steam-shovel operations between that date and Sept. 15 will reduce that amount to approximately 650,000 cu.yd., which will be taken out by dredges.

It is the intention to retain 10 of the best conditioned shovels in service, using them in the work of removing material from the east and west banks, near Culebra, to lessen the danger from slides.

Water will be admitted to Culebra Cut, under the above schedule, on Tuesday, Oct. 5, by four 26-in. pipes extending underneath the dike, now used in pumping the drainage water out of the canal. The equipment in the pump station will be removed prior to Oct. 5, and the concrete building in which it is housed will be dynamited.

It is estimated that it would take 17 days to fill the canal to the level of the dike by this method, and the water that will be admitted in the 5-day period is mainly intended to act as a cushion against the Gamboa dike, which will be dynamited on Oct. 10.

Gamboa dike was built in 1908 to protect Culebra Cut from inundation from freshets in the Chagres River. When Gatun Lake rose to over 50 ft. in the latter part of 1912, the dike was raised to an elevation of 78.2 ft. above sea level. When the water in Gatun Lake reached 59.1 ft. on Aug. 23, it was still 19.1 ft. below the highest part of the dike.

It has later been announced that the flooding of the cut will be started Oct. 9, not Oct. 5, as stated above.

Boiler Performance Tests under Forced Firing were completed in April on a 736-hp. Edgemoor water-tube boiler in the Westport Station of the Consolidated Gas, Electric Light & Power Co., of Baltimore, Md., under the direction of J. S. Barstow, superintendent of steam stations. The tests were run to determine the fulfillment of builder's guarantees, but the data is of interest in itself. The boiler in question was 15 tubes high and 22 tubes wide, having a total heating surface of 7361 sq.ft.; there were four passes of the gases. The working pressure was designed to be 200-lb. gage. Superheater elements were attached having an outside surface of 429 sq.ft. An underfeed stoker was used. Coal was measured with tested platform scales; water evaporated was measured in a calibrated tank; flue gases were analyzed in an Orsat apparatus, and setting temperatures were determined by an electric pyrometer. A preliminary test at 318% of rating (2340 hp.) was made for two hours, after which the boiler was cooled down and examined for damage. None having developed, preliminary tests at 210 and 248% rated capacity were continued for eight hours each, without indication of leaks or strains. The official performance tests were made at 210.5 and 248.5% of rating. A semi-bituminous run-of-mine Somerset coal was used, which showed about 19% of volatile matter and 68% fixed carbon, 9% ash, and less than 2% sulphur, with approximately 14000 B.t.u. per pound of coal as received. At 210.5% rating, the chimney showed a slight haze and at 248.5% there was a light gray smoke. CO determination showed 0.03% and 0.16% respectively. The summary of principal results is given in the following table:

Per cent. of rating developed.....	210.5	248.5	318
Steam pressure, lb. per sq.in., gage..	169.7	167.4	172.1
Superheat, F°.....	130.4	106.6	103.5
Pressure in tuyére box, in. water...	2.69	3.68	5.3
Draft in furnace, in. water.....	0.09	0.03	....
Draft at bottom of last pass, in. water	0.76	0.88	1.2
Temperature of feed water F°.....	105.5	90.9	88.3
Temperature of escaping gases F°..	550.6	584.7	....
Interval between dumpings, hr.....	2.6	2.0	....
Equivalent evaporation, lb. per lb. of dry coal	10.98	10.77	....
Equivalent evaporation, lb. per sq.ft. of heating surface per hr.....	7.26	8.57	10.97
Horsepower developed 1549		1829	2340
Efficiency of boiler and grate, %...	74.7	72.8	....

As the acceleration of the rate of evaporation, in an emergency, is of considerable importance in this plant, a further test to study this was made on the same boiler. The fire was kept in a smoldering condition for one week by feeding coal at the rate of about 220 lb. per hour. At the end of this time, the fuel bed was in poor shape and the brick work was cold. The run was started with 8¾ in. of water in the gage glass, and after seven minutes the feed valve was opened for two minutes, then closed for two minutes, and then left open until the close of the test. Output was determined by means of a recording steam-flow meter in the main pipe outlet. The time required to obtain different percentages of rating was as follows:

50%, 1.7 minutes.
100%, 2.3 minutes.
150%, 4.7 minutes.
200%, 7.8 minutes.

PERSONALS

Mr. I. H. Farmer was recently appointed Right-of-Way Engineer of the Seaboard Air Line Ry., Portsmouth, Va., vice Mr. G. H. Earp, resigned.

Mr. Samuel H. Lea, M. Am. Soc. C. E., formerly State Engineer of South Dakota, has been appointed City Engineer of Charlotte, N. C., to take effect Sept. 15.

Mr. Edward L. Moreland has been appointed Manager of the Boston office of Messrs. D. C. & Wm. B. Jackson, Engineers. The firm announces the removal of the Boston office to 248 Boylston St.

Prof. A. Riebe, Director of the Riebe Kugellager & Werkzeug Fabrik, Berlin, and prominent in the development of ball bearings, is visiting the United States and will lecture before the Society of Automobile Engineers.

Mr. Walter Loring Webb, M. Am. Soc. C. E., M. Am. Ry. Eng. Assn., has resigned his position as Chief Civil Engineer with Day & Zimmerman, Philadelphia, Penn., to open an office as a Public Utility Engineer, in the same city.

E. K. Kauffman, formerly Assistant Engineer of the Commonwealth Engineering Co., Oakland, Calif., has resigned that position to enter into a partnership with V. M. Price, to be known as the Kauffman-Price Construction Co., Oakland, Calif.

Mr. Page Harris, Superintendent of Transportation, Texas & Pacific Ry., has been elected Vice-President of the National Lumber & Creosoting Co., in charge of sales, with headquarters at Houston, Tex. Mr. Harris has been connected with the Texas & Pacific Ry. continuous since 1887.

Mr. J. N. Finlayson has been appointed Professor of Civil Engineering at Dalhousie University, Canada, vice Professor C. D. Howe. Mr. Finlayson was educated at McGill University, and later served for two years as instructor in the department of civil engineering at McGill. He has been with Waddell & Harrington, consulting engineers, during the past two years.

Mr. E. E. Sands, Supervising Engineer, department of Natural Resources, Canadian Pacific Ry., with headquarters at Calgary, Alta., was recently appointed City Engineer of Houston, Tex., succeeding Mr. Frank L. Dormant. Mr. Sands is a graduate of the University of Wisconsin, class of 1900, where he served for the two succeeding years as instructor in civil engineering, when he entered the U. S. Reclamation Service.

Mr. Clayton N. Woodward has been appointed General Superintendent of the Eastern Grand Division New York, New Haven & Hartford R.R., with headquaters at Boston, Mass. This division comprises the lines east of Willimantic and New London, Conn., and also the Boston, Providence and Old Colony divisions. Mr. Woodward has been connected with the New Haven or its absorbed lines since entering railroad work, in 1882.

Mr. John A. Droege, formerly Superintendent of the Shore Line Division of the New York, New Haven & Hartford R.R., has been appointed General Superintendent in charge of the operation of the Western Grand division, which comprises all the lines west of Willimantic, and New London, Conn. Mr. Droege began railroad work in 1880 as a train despatcher on the Baltimore & Ohio R.R. He was Chief Train Dispatcher on the Georgia R.R., 1885-1897, Trainmaster on the Southern Ry. 1897-1900, Superintendent of the New York Division of the Lehigh Valley 1900-1904 and since then Division Superintendent New York New Haven & Hartford R.R.

Morrell Vrooman resigned, Sept. 2, as City Engineer of Gloversville, N. Y., where he has served as Assistant City Engineer for two years and City Engineer for 12 years. He will in the future devote his time to the engineering firm of Vroo-

man & Perry, Sanitary Engineers, of Gloversville and Amsterdam. Harry J. Hanmer, for the past six years Assistant to the City Engineer, was appointed City Engineer to succeed Mr. Vrooman.

Albert E. Guy has just terminated a two-years' engagement with the Wilson-Snyder Centrifugal Pump Co., of Pittsburgh, Penn. In his capacity as Chief Engineer for that company, he designed and established their complete lines of single and multi-stage centrifugal pumps for steam turbine and motor drive. While still retained as Consulting Engineer, by that company, he will become, Sept. 15, Mechanical Engineer of the Providence Engineering Works, Providence, R. I.

T. J. Driscoll, for the past year and a half connected with the engineering department of the Pittsburgh Crucible Steel Co., on the construction of their new plant at Midland, Penn., has been appointed Chief Draftsman to take effect Sept. 1. Mr. Driscoll, for seven years, was in the engineering department of the Pennsylvania Steel Co., Steelton, Penn., and previously with the Wellman-Seaver-Morgan Engineering Co., on outside construction. He is a graduate of the Massachusetts Institute of Technology, class of '99.

OBITUARY

Wm. H. Leach, M. Am. Soc. M. E., Research Engineer for the Union Metallic Cartridge Co., Bridgeport, Conn., died at the home of his father in Newton, Mass., Sept. 7.

Thurston M. Phetteplace, M. Am. Soc. M. E., Assistant Professor of Mechanical Engineering, Brown University, died at a hospital in Portland, Me., Sept. 7, at the age of thirty-six years.

J. L. Champion, City Engineer of Eveleth, Minn., died in that city, Sept. 1. Mr. Champion was employed for some time as a mining engineer before assuming the position held at the time of his death.

Colonel C. A. Sterling, who was for 30 years president of the National Storage Co., of the Standard Oil Co., died at his home in East Orange, N. J., Sept. 6, at the age of 70 years. Colonel Sterling was vice-president of the Public Service Corporation of New Jersey from 1903 until his retirement about five years ago.

George M. Hughes, President and General Manager of the New Jersey, Indiana & Illinois R.R. Co., died Sept. 8, at his home in Brooklyn, N. Y. Mr. Hughes was born at Southfields, Orange County, N. Y., in 1843, entered railroad work in 1863 as a telegraph operator with the Erie R.R. Later he became station agent and then general contracting agent for the Erie R.R. He was appointed to the position, held at his death, in 1905.

Charles Jones, M. Inst. C. E., F. S. I., a founder, Past President and Honorary Secretary of the Institution of Municipal and County Engineers, died on Aug. 24, after a few hours' illness, at the age of 83 years. Mr. Jones was to retire from the office of borough engineer and surveyor of Ealing, England, after 50 years' service, and as a mark of appreciation of his services, the council of that borough had chosen him mayor for the ensuing year. Mr. Jones was a native of Beccles, Suffolk, moving to Ealing in 1856. His professional work included among other things the laying out of four parks aggregating 107 acres in extent. He was a pioneer in the field of scientific refuse disposal, and was the author of a book upon the subject.

James Richard Bell, M. Inst. C. E., whose death was briefly noted in our issue of Aug. 28, was one of the best known English engineers in India, and one who had played an important part in the development of that country's resources. He was born in 1841, the grandson of James Brenner, and a nephew of David Bremner, both famous English engineers.

Mr. Bell was educated at Aberdeen Gymnasium, served an apprenticeship with a famous engineering firm in Adelphi, served on various surveys in England and Wales and on the construction of the Cairo Ramelah Ry. in Egypt. He first went to India in 1868 on a five-years' contract with the Public Works Department. Here he was employed for a time on irrigation work in the Madras Presidency, but later was transferred to the State Rys., in the construction and maintenance of which he achieved his greatest fame. In 1875 he supervised the construction of the famous Empress Bridge over the Sutley River for the Indus Valley State Ry. This bridge consists of 16 spans of 264 ft. each; each pier consists of three brick cylinders sunk 100 ft. below the river level. Mr. Bell was the original of Kipling's "Bridgebuilder." He also designed and supervised the construction of novel works for training and improving the Indus River.

About in the fall of 1879 Mr. Bell was selected to take charge of the surveys and construction of a railway from Ruk, south of Sukkur to the Bolan Pass. The British Government, following the Cavagnari massacre at Kabul, were compelled to reoccupy certain strategic points in Afghanistan and the extreme need of through railway connection to the Bolan Pass was apparent. In this work Mr. Bell had to contend with the most extraordinary difficulties. The route had not even been surveyed, no material existed, and for the most part the railway line ran through a waterless desert. In 101 days, Oct. 4, 1879 to Jan. 14, 1880, 113½ miles of this railway were surveyed and constructed, and the line opened for traffic of military stores, under Mr. Bell's direction. Later he was engaged in railway and bridge building in many parts of India.

In 1894 Mr. Bell reached the highest engineering post in connection with the Indian State Rys., and for two years (until his retirement) was Consulting Engineer to the Government of India for State Rys. He was the recipient of many honors, both as an engineer and railway builder and as a patriot and faithful servant of his native country. [Abstract from the "Railway News," London, England, Aug. 2, 1913.]

ENGINEERING SOCIETIES

COMING MEETINGS

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Sept. 17-18. Tenth annual meeting at Cleveland, Ohio. Secy., W. P. Blair, 824 Engineers' Building, Cleveland, Ohio.

INTERNATIONAL CONGRESS OF REFRIGERATION.
Sept. 17-Oct. 1. Third congress, at Chicago, Ill. Secy., J. F. Nickerson, Chicago.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 22-26. Annual convention at Pittsburgh, Penn. Secy., I. D. Israel, 29 W. 39th St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 22-24. Annual meeting at Pittsburgh, Penn. Chairman, H. M. Wilson, 40th and Butler Sts., Pittsburgh, Penn.

AMERICAN ROAD CONGRESS.
Sept. 29-Oct. 4. Annual convention at Detroit, Mich. Gen. Secy., J. E. Pennybacker, Colorado Bldg., Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 7-10. Annual convention at Wilmington, Del. Secy., Geo. H. McGovern, Chamber of Commerce, Wilmington, Del.

RAILWAY SIGNAL ASSOCIATION.
Oct. 14-16. Annual meeting at Nashville, Tenn. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 13-17. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Oct. 15-17. Annual meeting at Richmond, Va. Secy., Geo. G. Ramsdell, 29 West 39th St., New York City.

NATIONAL SOCIETY FOR PROMOTION OF INDUSTRIAL EDUCATION.
Oct. 19-25. Annual convention at Grand Rapids, Mich. Secy., C. A. Prosser, 105 E. 22d St., New York City.

AMERICAN MINING CONGRESS.
Oct. 20-25. Annual convention at Philadelphia, Penn. Secy., J. Callbreath, Majestic Building, Denver, Colo.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 21-23. Annual convention at Montreal, Que. Secy., C. A. Lichty, 319 North Waller Ave., Chicago, Ill.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 28. Annual Convention at Washington, D. C. Secy., Wm. H. Connolly, Interstate Commerce Commission, Washington, D. C.

Engineers' Society of Pennsylvania—The Pennsylvania Industrial Welfare and Efficiency convention, under the auspices of the society, will be held at Harrisburg, Penn., Oct. 28-30. The exhibit will be of a general engineering nature, along the lines of the two previous conventions of a like character held in 1909 and 1910. J. V. W. Reynders, of Harrisburg, Penn., is Chairman of the Exhibit Committee.

American Society of Refrigerating Engineers—The next annual meeting will be held at New York City, Dec. 1-2, in the Engineering Societies Building.

Massachusetts Street Railway Association—At the annual meeting, at Boston, Sept. 10, the following officers were elected for the ensuing year: President, H. H. Crapo; Secretary, Charles S. Clark, 70 Kilby St., Boston, Mass.

ENGINEERING LITERATURE

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EDITORIAL COMMENT

Apropos of our recent review of Mr. Riker's "Power and Control of the Gulf Stream," we find accompanying the speech of the Hon. William M. Calder, of New York, made in the House of Representatives, Mar. 1, 1913, the following gem:

> Unimpeded drops of water, and impeded grains of sand,
> Will change the ocean's bottom and the surface of the land.

And:

> The like of woman's hairpin and the shoestring of the man,
> With the aid of friendly nature, will construct this mighty dam.

Mr. Calder, by the way, was advocating the passage of House Bill 28239, providing for the appointment of a commission to investigate Mr. Riker's scheme with an appropriation of $100,000.

The lines quoted, we take it, are also from the pen of Mr. Riker, and like his book are intended to eliminate all doubt as to the feasibility of his improved method of building the proposed jetty by a submarine cable.

Mr. Calder himself is responsible for the following:

> The simplicity, cheapness, and feasibility of the plan appeal at once to the scientist, engineer and the old salt. Not the least argument that would weigh, in many instances, would be their own experiences as boys with the mud puddle in the gutter.
>
> With man's direction and assistance, Old Neptune will willingly bear the yoke of servitude, working unceasingly in sunshine and storm, night and day and at all seasons, to complete this mighty work. Nevertheless, he will require careful watching, especially while nearing the completion of his job.

This sort of thing adds to the gayety of nations, but not to the dignity of Congress. It has one advantage, however; it makes plainer to some people than could be made by serious argument how ridiculous the whole plan of either a jetty or an investigation of that or any similar project is. Give the calf rope enough and it will kill itself.

REVIEWS AND NOTES

An Enlarged and Rewritten Edition of Thomas and Watt on River Improvements

Reviewed by WILLIAM W. HARTS*

THE IMPROVEMENT OF RIVERS—A Treatise on the Methods Employed for Improving Streams for Open Navigation by Means of Locks and Dams. By H. F. Thomas, M. Am. Soc. C. E., United States Principal Assistant Engineer, and D. A. Watt, M. Am. Soc. C. E., United States Assistant Engineer. Second edition, rewritten and enlarged. New York: John Wiley & Sons. London, England: Chapman & Hall. Cloth; 9x12 in. In Two Parts. Part I, pp. xiv+369; 83 text illustrations and 45 plates. Part II, pp. viii+415; 87 text illustrations; 38 plates. Set, $7.50, net.

River engineers will be particularly interested in this new edition of "Improvement of Rivers." The original book has been amplified and enlarged so that the contents of the revised work have, of necessity, been divided into two quarto volumes of over three hundred pages each, more than double the original size. The plates showing various examples of existing types of river improvement have been increased in number from 18 to 76, and the tables of the costs of construction at the ends of the various chapters have been materially added to, all of which enormously increases the value of the new edition. The original edition, published in 1903, was reviewed in "Engineering News" of May 14, 1903, at which time attention was called to the many valuable features presented.

Facility of transportation is one of the foundation stones of prosperity in any country, and more particularly is this true of the United States, where distances are so great and producer and consumer usually so widely separated. It will be realized at a glance why the importance of our internal waterways was very early recognized when one remembers that the railroads, both before and soon after the Civil War, had not reached a wide development, and the rivers were thus necessarily the most important arteries of commerce then available.

The days of the floating palaces on the Mississippi and Ohio Rivers gave way before many years to the era of the railroad, and many of our busiest rivers of two generations ago have declined in importance as freight carriers under the fierce competition of the railways, which have been striving for a larger and larger share in the carrying business of the country. The contest has gone on until the river traffic is now largely limited to special streams and special commodities.

Under this influence we have seen the river traffic of various streams diminish until elaborate works of improvement in some cases stand almost idle, a melancholy testimony to the unexpected changes wrought by the progress of events and mute witnesses to a losing struggle for the mastery of the transportation business of their localities. A new basis for government construction is slowly being established in this country, for there are still streams, such as the Ohio and the Hudson, where freight is bulky and may be expected to be economically handled by water for many years to come. On these streams judicious and beneficial work is still possible. In other cases, such as the Mississippi and Sacramento, the problems of flood control and drainage are rapidly making common cause with navigation, and are yearly demanding more and more public recognition and assistance. Many other streams are being abandoned altogether.

It seems probable that our principal rivers will soon be given attention of a new kind, so that all the related interests of water power, flood control, drainage and navigation will each be accorded its proper share and given the recognition it deserves in a united development under a single control.

*Major, Corps of Engineers, U. S. A., Army War College, Washington, D. C.

The wide subject of river improvement, therefore, seems to be developing far more in these latter-mentioned directions than many realize, tending to offset the amount it is contracting in other directions, so that the profession of the river engineer may be more than ever looked to in the near future for methods of achieving new benefits for large areas and populous communities. It cannot be denied, however, that the the improvement of rivers has not received the attention at the hands of professional engineers of experience in this country that the subject seems to deserve and the publication of any reliable work relating to this department of the profession is particularly welcome to a class of engineers, not large, it is true, but forming a very important part of those engaged in construction work of internal improvement for the public benefit.

Perhaps one reason for this lack of greater attention to this subject is that these works are of a special nature and their application is somewhat restricted, while most of the results are not conspicuous, but are usually hidden under the water surface, often in out-of-the-way places, so that the benefits are known only to a few, mainly those concerned in navigation and its allied interests. Perhaps another reason for this lack of popular knowledge of these matters is that such works have, for more than three generations, been almost exclusively in the hands of the Corps of Engineers of the U. S. Army, an organization small in numbers, and not much given to writing, but whose highest commendation is found in the excellence of its works extending from coast to coast, and its practically unbroken history of unselfish devotion to the public service for nearly a hundred years.

In the early thirties, we find the plans of Col. S. H. Long for the improvement of the Tennessee River receiving earnest attention from President Jackson, whose interest in this work inspired the early studies made at that time. Federal improvements of certain streams in Delaware and Connecticut were commenced a few years earlier.

In the early fifties, we find Lieut. George B. McClellan (later commander-in-chief of the Union Armies) engaged in the work of studying the needs of the various rivers and in carrying on many works of improvement along the Tennessee River and on other Southern streams.

About the same time, Col. Barnard, with several other engineer officers, was engaged in the problem of solving the puzzle of the mouth of the Mississippi. At this time he advocated with great earnestness and persistence his proposed plan of opening the mouth of this great river, then an artery of the greatest commercial value, by using the system of parallel jetties, a plan adopted some twenty years later and carried to successful completion by James B. Eads.

Later, we find the locks at Saulte Ste. Marie built by Gen. G. Weitzel and Gen. O. M. Poe, works which are pointed out by most writers on American practice as exceptionally well-designed and constructed for their purposes. We see, in the seventies, the great reservoir system of the Mississippi designed by General Warren.

The bank protection of the Mississippi, the study of the hydraulics of this great stream by Generals Abbott and Humphries, the regulation of the upper Mississippi, the levees of the lower Mississippi, the movable dams on the Ohio and Kanawha, the lateral canals on the Ohio, Tennessee and Mississippi, the canalization of several of the tributaries of the Ohio, the reclamation of the Sacramento basin from the menace of mining débris and floods, the development of the jetty system of deepening river bars on sandy coasts, the greatest artificial reservoirs of the world, and more recently the Panama Canal, all show the wide variety in work on which the Corps of Engineers has so long been engaged. It is, therefore, particularly gratifying to find a new book in which a number of these American works have been described as American types and in which examples are furnished for study to illustrate the general principles of river improvement expounded. It may be a good ground for criticism, however, more particularly of the first volume, that more of our American practice was not used and descriptions given in more detail; perhaps with a corresponding reduction in number of foreign examples cited. For American engineers, American experience should be more valuable than foreign, and although foreign works are often more fully written about, and for this reason maps and descriptions may be easier to obtain than those of American examples, still it must be said that for this very reason, a greater use of the work of the American engineers would be far more useful in an American treatise of this kind. The reason for this conclusion is not far to seek. The labor conditions abroad permit a very elaborate character of construction and require a corresponding economy of material. Here in America, economy in labor is usually the more important and the character of work is accordingly in many instances widely different.

This difference in the cost and kind of labor available abroad is only one of the features which make another kind of work necessary here. The length and discharge of our rivers is in many cases so much greater than in rivers in other countries that often original plans of work must be devised to meet our requirements. To use the elaborate system of spurs made of brush woven into baskets and weighted with stone at one time in extensive use in Germany and India would be found wholly inadvisable on most of our rivers. As curious specimens of work they are interesting and help round out a book on this subject, but it is questionable if its real usefulness is much helped thereby. One of the members of the National Waterways Commission, who visited the principal river improvement works of Europe, is said to have stated on his return that this country had but little to learn from Europe in this particular, as most of the types of successful river work there could be found better designed, better constructed and more efficiently operated here.

The book, however, taken as a whole, is a very excellent textbook for students who are taking up this subject from the beginning, but for the more advanced engineer, it will be used rather as a book of reference from which he will be inclined to turn to those special papers of authors of more direct experience where greater detail is found, if he wishes to study, at all exhaustively, many of the works mentioned—especially in the first volume. As a large and well chosen collection of many kinds of river improvement, it may be said that the new book plainly justifies itself, and quotations from papers and books of expert engineers have been liberally introduced, in one case to the extent of near an entire chapter. But where original opinions are advanced, or conclusions reached from stated facts, engineers will, as usual, be compelled to differ in many instances and adopt their own views as to the expediency of following many of the methods advocated, such as the use of buckle plates in lock gates, and the choice of lock valves preferred by the authors.

The upper Mississippi, for example, for over 600 miles, is an unusually successful specimen of open-river regulation and an extended study of the methods used there, with maps, would be of much greater value to the American engineer than the very casual comments on this improvement.

And again, the corresponding method of regulation on the Ohio was abandoned many years ago, but the fact is not stated nor reasons given in the book. The actual reason was that greater depth and certainty were required by commercial necessity than the method of open-river regulation, formerly adopted, would warrant. It is just such omissions that leave something to be desired that the experienced engineer will often notice.

The book cannot be considered as an exhaustive treatise of any of the forms of improvement discussed except canalization by movable dams, but it is probably expecting too much to look for a full description of more than a single department of a subject of such a comprehensive nature.

The use of references is not so extensive as could be wished. The original sources could be stated and proper credit for many ideas given in this way. Occasionally unusual statements appear which could be traced by the reader from proper footnotes, if his interest should incline him to look further. For example, a statement is made that in the Appenines a river was found flowing 30 ft. above the general level of the surrounding country. The name of the river and the authority are both omitted, although such a case is interesting enough to have the name and discoverer quoted.

The arrangement of the book in two volumes, one of which is devoted to open-river improvement, and one to canals and canalization, is an excellent one, and the arrangement of chapters in each is progressive, except in the first volume, in which the chapter on dredging is sandwiched in between two unrelated parts.

As a collection of interesting and instructive examples of various kinds of practice, the book will be of considerable use to many river engineers to whom the many hints and valuable suggestions will undoubtedly be well worth the cost. But, as before mentioned, it is to the student of river engineering who is taking up this subject from the beginning that the book will especially appeal, and for this class of readers it is probably the best American work available.

The chapters on movable dams stand out far beyond the remainder of the book in point of excellence, and of themselves form a treatise that is exceptionally good from whatever point they may be viewed. These chapters and the many new plates, together with the cost data, form for the practicing engineer by far the most useful part of the work. If the remainder of the book is rather elementary, it must be remembered that the wide scope of the subject, would not permit a very full discussion of all points, and that it would

be impossible to treat at much length the great variety of subjects included.

In Part I, the chapter on Characteristics of Rivers is more than three times as full as in the first work, and contains a fairly complete description of the many river features ordinarily met with. It is interesting but necessarily rather general in its nature, and not specially useful to the average engineer. All the discussion of the first book concerning preliminary examinations and hydrographic surveys of rivers has been wisely omitted from the revised volume, as such information is better obtained from works specially devoted to the subject of surveying.

The chapter on Regulation of Rivers is a disappointment. The examples illustrating principles are not always well chosen. Too little reference is made to the necessity of studying closely both the old and the proposed new slopes of the water surface and the limits of improvement are not fully commented on. More concrete cases might be profitably cited and more illustrations from actual practice included, space therefor being made, if found desirable, by eliminating a sufficient amount of less valuable matter.

The chapter on Dredging is a great improvement on the first edition, but still leaves considerable to be desired. The location of channels for best results is not well discussed. The statement of costs is needlessly scattered and not always clear, and several detailed plans of successful river dredges and snag boats might well have been added for the guidance of engineers engaged on this kind of work.

The chapter on Dikes is also much fuller than in the original edition. It is still by no means complete and will be only of general service to the practical engineer. The use of sills is only cursorily commented on, and the choice of the use of spurs or longitudinal dikes aided perhaps by sills, or a combination of all these types, is not adequately discussed. To the average river engineer this chapter may also be something of a disappointment in that it does not furnish anything very definite for his own use in designing these adjuncts of river training.

The chapter on Bank Protection is probably the best in the first volume. It is nearly all new and is well described. The illustrations are from examples of good practice, and the chapter as a whole will be found to be above the others in clearness and usefulness. More space might have been given to the various American processes of mattress weaving, but the subject is otherwise well covered and will be found valuable.

Next to the chapter on Bank Protection in point of excellence comes the chapter on Levees. Levee cross-sections, material, construction and maintenance are all well discussed, but levee location has not been given the attention it deserves.

The chapter on Storage Reservoirs is mainly a quotation from the work of Gen. H. M. Chittenden, as indicated in the footnotes, 22 of the 27 pages being quotations from his work on "Reservoir Sites in Wyoming." The information is general. The history of the abandonment by the government of this method of improving the navigability of the Fox and Chippewa Rivers, and of the upper Ohio in this country, and of several rivers of both England and France by their respective governments, might have been included as well as some of the recent projects proposed for reservoirs on the upper Ohio by various flood commissions, together with their estimate of cost.

The chapter on Improvement of Outlets of Rivers is very superficial. The sand movement at such outlets, the theory of bar formation, location or jetties, amount of contraction necessary, and methods of construction are only lightly touched upon. The distinction between bars in tideless seas and those in tidal waters is only casually referred to, and the great difference in treatment is not pointed out very carefully. Many examples in this country might have profitably been described more in detail, such as Gray's Harbor, Humboldt Bay, and the entrances to Charleston, Galveston and New York harbors. It should scarcely be expected that such a complex subject as the improvement of the mouths of rivers would be fully treated in a single chapter, and for this reason due allowance must be made for the brevity of the discussion.

It is particularly to the second volume that the engineer may look for the main justification of this work. The first chapter is entirely new and is full of useful hints on lock design and construction, particularly that part which relates to cofferdams. The rest is mainly general, and many engineers may differ with the authors in some details such as the desirable heights of lock-walls above the pool levels, but on the whole, the chapter will be found of much use.

The chapter on Locks has been added to and will be found of great value to the student. It might be added, however, that the computation of wall dimensions is neither as clear nor as full as could be desired for this class of readers. The discussion as to concrete proportions, mixing and placing, etc., is scarcely necessary in a book of this kind, and could well have been omitted. But, on the whole, the value of the chapter will be recognized, due to the many valuable suggestions bearing on lock-wall construction.

The chapter on Lock Gates and Valves is nearly all new and is a very fair descriptive review of the practice for the past 20 years, mainly in this country. The computations of strains and the proportioning of gate members is not given the attention that the average engineer would probably like, nor are the valves described in much detail. Gates and valves are the most intricate parts of the lock, and might well be the subject of an entire book. Wooden gates are disappearing and steel gates are now the rule, even for small locks. There are many types in this country of steel gates other than those shown, and their plans might well have been included.

The chapter on Fixed Dams is, like the foregoing chapter, a review of the practice in this country of the last 20 years, largely on small streams. It relates mainly to wooden dams. The use of wood in dams is also now diminishing owing to its increasing cost, and concrete is fast taking its place. A fuller discussion of concrete dams might have been more useful, but this, too, is a wide subject, well treated in other works of a more special nature. Foundations are of extreme importance in all locks and dams far more than in most engineering construction. This arises from the active, incessant efforts of the hydraulic head to search out weak places and attack the structure wherever they are found. For this reason it might appear that the portion devoted to foundations, concerning which some valuable data have been given in this volume, might have been profitably extended to cover many other cases commonly met with. Particularly is this true with work founded on sand or gravel where underscour must be guarded against with the greatest care.

The five chapters relating to Movable Dams deserve little else than the warmest praise. The description of various kinds of movable dams with the photographic prints of examples under construction and in operation, together with the number of clear plates, many of which show dimensions and specify locations, is a treatise in itself of great value. There is too little available literature on this subject, and the authors' personal experience in this kind of work insures a wise choice of types for illustration. The two main types of movable dams in this country are needle dams and wicket dams, and these types are described with a detail that will be found very satisfactory to the engineer who may have this character of work to design. Various specimen types, such as bridge dams, gate and curtain dams, bear-trap dams, etc., are also treated with a care that gives this part of the work great value. This portion of the book can be safely commended to any engineer who may have this class of construction to do. All these five chapters have been considerably added to since the first work was published.

The tables at the end of the book which show the locks and dams in this country and abroad with their various dimensions, dates of construction, materials of which built, and foundations, are brought up to date as far as practicable.

The book is handsomely printed and illustrated and will be found to be a creditable addition to any river engineer's library.

LONDON MOTOR TRAFFIC—Report from the Select Committee. London, England: Wyman & Sons, Ltd., Fetter Lane, E. C., and T. Fisher Unwin. Paper; 8x13 in.; pp 42. 4½d.

The committee named above was appointed on Nov. 27, 1912 "to inquire into the circumstances which have led to the large and increasing number of fatal accidents in the metropolis, due to motor omnibuses and other forms of power-driven vehicles, and to make recommendations as to measures to be taken to secure greater safety in the streets." The report contains accident and traffic statistics for London, together with a review of various traffic conditions making for accidents and measures which might be adopted for reducing the number of accidents. Considerable space is also given to the overlapping and conflicting authorities which have greater or less control over London traffic. These authorities include the Home Secretary of State under whose jurisdiction is the London police, the local Government board to a slight extent, the Board of Trade, the London County Council, the various borough and city councils included in the administrative county of London and various county councils, borough and town councils, etc., outside of the jurisdiction of the London County Council. The committee recommends that the present Traffic Branch of the Board of Trade be reconstituted and its powers somewhat enlarged and that all new legislation regarding traffic matters should be submitted to

Parliament by the new Traffic Branch and by it only. The by-laws regulating the traffic enacted by the various municipal bodies in Greater London, the committee recommends, should all be subject to the approval of the new Traffic Branch. Apparently the committee also favors the taking away from the various boroughs and cities comprising the County of London the right to veto tramway extensions proposed by the London County Council. The interest and value of the report lies largely in the consideration which it gives to motor omnibuses and other motor vehicles and in the statistics showing the large number of accidents and injuries due to these vehicles.

All Sorts of Excavators

Reviewed by Wm. B. Landreth*

EXCAVATING MACHINERY—By Allen Boyer McDaniel, M. Am. Soc. C. E., Assistant Professor of Civil Engineering, University of Illinois. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xviii + 340; 134 illustrations. $3, net.

The basis of this book is a set of notes used by the author in his class-room and thence expanded to meet practical needs in the field, having in mind "not only the engineer and the contractor, but also the farmer, land owner, promoter and officials charged with the construction of public works." Each chapter gives a description of the machines, cites places where they have been used, cost data and a résumé and Bibliography.

The general plan of the author has been to describe the smaller machines first, then the larger and more powerful ones, thus leading the reader by easy stages to the consideration of machines of the greatest capacity.

In Chapter 2, some very interesting data and illustrations are given of the use of road scrapers in building irrigation ditches in the West, where those machines have been put to uses new to the Eastern engineer.

The chapter on steam shovels gives a very full description of the construction, capacity, weight and cost of operation of the machines, and numerous instances of their use in all parts of this country. The cost data is very complete as it gives costs in various classes of material and conditions of operation.

The author divides dredges into dry land excavators and floating excavators, a new but logical classification. The description of the self-propelled or "gopher excavators" is very interesting and the illustrations very complete. The drag-line scraper, a comparatively new type, that is being used more and more as its capabilities are learned, is described in detail, supplemented by numerous illustrations, with statements of cost of operation. The tower excavator, a type of drag-line scraper deriving its name from its movable tower resting on a platform or car, is shown in two illustrations, with a description and cost of operation. This type of excavator is in general use in the construction of the New York State Barge Canal in building dikes, excavating lock sites and canal prism and owing to its low first cost and small operating charges has proved an economical means of excavating, and also for transporting material for hauls under 300 ft.

In Chapter VII is given a complete description of dipper dredges, with instances of their use and cost of operation. The author presents strong arguments showing the folly of building light, low-cost dredges for heavy work. The description of ladder dredges is sufficient for a knowledge of their special requirements; their use on various pieces of work is fully described and the cost of operation given. Drill boats and the Lobnitz rock cutter are also described and illustrated in this chapter, with operating costs and instances of use. The description and other matter on hydraulic dredges fill 20 quite fully illustrated pages with a very full Bibliography.

Chapter VIII, on trench excavators, covers traveling derricks, continuous bucket excavators, trestle excavators, tower cableways and several forms of traction excavators used in trench excavation, with full specifications of a locomotive crane, supplied with grab-bucket equipment. Considerable data of cost of operation of the various machines are given.

Chapter IX gives a very clear statement of the adaptability of the various types of machines used in levee building, with reasons for the use of certain types of machinery on that class of construction. This chapter will be of great aid to engineers or contractors who have to choose and operate machinery in levee construction.

In Chapter X, on the comparative use of excavating machinery, the author makes the trite statement that:

It is clearly impossible to lay down any rules or state any formulas by means of which an excavator could be arbitrarily selected for any proposed work. There are always so many variable conditions and unknown and unforeseen factors to consider, that it is to a great extent a matter of judgment. This essential, but rare quality, is born in some people, but, by most of us must be acquired by experience.

He then gives cost data of work done by dipper dredges, wheel scrapers, drag-line excavators and steam shovels in various localities.

Appendix A gives a general specification for a modern steam shovel for railroad work taken from a report of a subcommittee of the American Railway Engineering and Maintenance of Way Association with the recommendations made by the committee. The tests of the Mississippi River Commission for Hydraulic Dredges are given in Appendix B. The index is well arranged and complete.

The author's style is simple, forceful and concise, and the arrangement of the chapters and divisions admirable. The author has collected a large amount of valuable information that heretofore could only be obtained by reading several books and many periodicals and the book should be in the possession of everyone concerned in the choice or operation of excavating machinery.

THE REDUCTION OF DOMESTIC FLIES—By Edward H. Ross, author of "The Reduction of Domestic Mosquitoes" and "The Prevention of Fever on the Suez Canal." Philadelphia, Penn.: J. B. Lippincott Co. London, England: John Murray. Cloth; 6x9 in.; pp. viii + 103; 19 illustrations; $1.50, net.

The arguments for keeping domestic flies down to the lowest reasonable limit are interestingly and forcefully put in this brief volume. Particular stress is laid upon measures for "killing the fly-larvae when they are feeding in the manure heap." The way to do this "is to destroy the manure heap and all it contains"—once a week during the summer and at lesser intervals in colder weather. The word "destroy" is used to include removal and use for agricultural purposes by working it into the soil immediately. The importance of making a study of each locality in order to determine just what damage flies are likely to do there is emphasized and suggestions for "fly brigades" are made.

The book is a mere popular tract or bulletin compared with the American work by Dr. L. O. Howard, entitled "The House Fly—Disease Carrier" (see "Eng. News," Dec. 14, 1911), but it makes no pretense of being so complete, and frequently quotes from Dr. Howard as an acknowledged authority. Nor does the present work seem quite equal in merit to the same author's "The Reduction of Domestic Mosquitoes" (see "Eng. News," Nov. 16, 1911). Nevertheless, the British book against the domestic fly will be of great assistance in the world-wide campaign against that disgusting and dangerous pest.

THE 1913 FLOOD AND HOW IT WAS MET BY A RAILROAD—By Lewis S. Bigelow. Pittsburgh, Penn.: The Pennsylvania Lines. Paper; 5x8 in.; pp. 71; illustrated.

The Pennsylvania railway system brings out its story of the damage done by the great Ohio-Indiana floods of last March to its lines west of Pittsburgh. The story is well told, not systematically, and in the spotlight style of some newspaper reporters, but giving typical scenes, incidents and records out of the hundreds that would make up a complete history. Of the details that the engineer wants to know there is little. On the other hand many good pictures, of damaged structures, etc., are reproduced. Perhaps the most important item in the book is a pair of maps: one showing the Pennsylvania's normal trackage between Pittsburgh, Chicago and St. Louis, and the other showing the remnants of a railroad that were left after the flood wrecked bridges and embankments. When it is considered that even part of this latter map represents borrowed trackage, its remarkable character will become still more apparent.

ROCHESTER (N. Y.) SEWAGE DISPOSAL SYSTEM—Report by Edwin A. Fisher, City Engineer, Rochester, N. Y. Cloth; 6x9 in.; pp. 248; illustrated.

A series of reports embracing a number of valuable studies made to determine the best means of sewage disposal for Rochester is included in this volume, as well as reports on the construction of the intercepting and outfall sewer. The special reports extend from 1907 to 1912, but the history of sewage-disposal projects at Rochester for ten years is given, coming down to March, 1913. Several detailed reports on sewage treatment, written by Emil Kuichling, are given, as well as a number of reports made to the State Department of Health by various engineers when the plans for sewage treatment were before the department for approval in 1910 (see "Eng. News," Aug. 11, 1910). The grit chambers and

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Imhoff tanks proposed for Rochester are described briefly. A report by George C. Whipple, dated Oct. 31, 1912, giving an account of a study of the effect of Rochester sewage on the Genesee River and on Lake Ontario under present conditions, is also given. Mr. Whipple concluded that the new works should include provision for disinfection, although disinfection may not be necessary all the time. Several other important studies are reported, including one on sedimentation, made in 1909, to secure data for use in designing an inverted siphon for carrying sewage. The volume as a whole is a notable addition to municipal reports on sewerage and sewage disposal.

Electric Service for the Farm

ELECTRICITY FOR THE FARM AND HOME—By Frank Koester, Assoc. M. Am. Inst. Elec. Eng., Author of "Hydroelectric Developments and Engineering," "Steam Electric Power Plants," etc. New York: Sturgis & Walton Co. Cloth; 5x7 in.; pp. xiii + 279; 55 illustrations; $1, net.

The author evidentally aims to bolster up the general argument that electric power is the greatest of modern aids to the farmer. He reviews very optimistically the availability of central-station electric service to the farmer, the opportunities for isolated electric-power development, the cost of operating farm and domestic apparatus and he shows how electric power has been used for refrigeration, hauling, hoisting, plowing, pumping, milking, cooking and a multitude of other operations that come under the head of conveniences and refinements. He has interjected also some few pages on German farm by-products and the advantages of cold storage.

It would be unfortunate if any farmer after reading such a book should plunge into buying a lot of motor-driven farm apparatus and contracting with some electricity-supply company for considerable service, looking expectantly but ignorantly to the future for great economy and profits with a life of ease and higher mentality. The farmer probably would have some difficulty in buying, out of stock, a full equipment of power-driven machinery for all his operations. The cost of what he could get moreover would stagger him and unless he was wonderfully favored by low cost of energy, the items of interest and maintenance would eat up his gains.

The defensible use of such a book, then, is that it may lead a farmer to scrutinize his business from time to time to see where is possible the application of power, either mechanical or electrical, to cut down production cost and decrease family drudgery without wiping out any chance profits that may exist.

The details of the text of the book are open to some criticisms, though these may become of minor importance if the function of the book is to arouse interest in power farming rather than to serve as a guide and manual for power development and utilization. For instance, the author in considering hydraulic developments gives the farmer a choice of Pelton-type waterwheels for high heads, or turbines for low heads. But pretty nearly every American farmer will ask why he cannot use a good old-fashioned overshot wheel, and indeed these wheels, if fairly designed and built of steel instead of wood, still have a special field of usefulness for small isolated developments. Then, too, the author will not gain the confidence of his readers by asserting as he does that the trade balance of seventeen odd million dollars which is going into fertilizer importations would be saved by the use of American-made nitrates (fixed atmospheric nitrogen) for the farmer knows, if the engineer does not, that it is potash supplies that cause worry rather than nitrogen.

TABLES ANNUELLES CONSTANTES ET DONNEES NUMERIQUES DE CHIMIE, DE PHYSIQUE ET DE TECHNOLOGIE—Colaborated by S.-L. Archbutt and Many Others. Vol. II, 1911. (Ch. Marie, Secretaire general du Comite international, 9 rue ,de Bagneux, Paris VIe France). Paris: Gauthier-Villars. Chicago, Ill.: University of Chicago Press. Cloth; 9x11 in.; pp. xl + 759. $7.76, postpaid.

This enormous work, comprising 759 large size pages each filled with figures, has become an annual production. It contains all authentic figures of various constants used in chemistry, physics and other branches of technology which have been derived by various experts throughout the world. The text portion of the book is in English, French, German and Italian.

A new edition or imprint of "The Two Books on the Water Supply of the City of Rome of Sextus Julius Frontinus," Water Commissioner of the City of Rome, A. D. 97," as translated by Clemens Herschel, has appeared. (New York: Longmans, Green & Co., $6.82 by mail.) The new edition contains a number of corrections, besides which the foot-notes are brought up to date.

English Battleship Construction

Reviewed by D. W. TAYLOR*

THE MODERN WARSHIP—By Edward L. Attwood, M. Inst. N. A., Royal Corps of Naval Constructors. [Being one of the Cambridge Manuals of Science and Literature.] Cambridge, England: The University Press. New York: G. P. Putnam's Sons. Linen; 5x7 in.; pp. vii + 146; illustrated. 40c. net.

This little book, with only 142 pages of reading matter and 17 figures in the text, is by a member of the English Corps of Naval Constructors, who is well known by other works, notably, his "Warships," a textbook prepared primarily for English naval officers.

The present volume is exceedingly condensed, as, of course, it must be to deal in such a small space with the wide field of design, construction, armor and armament, equipment, stability, machinery, ventilation, watertight subdivisions, speed, and cost of warships. The information given relates entirely to English warships and almost altogether to English battleships and battle cruisers; torpedo vessels, for instance, are almost ignored.

The author has done his work well within the limits assigned and there is little to criticise about his production, although he falls into inaccuracies at times. Thus, on page 17 he gives the displacement of the "Olympic" at 34½ ft. draft as 60,000 tons. This is the press-agent displacement of the "Olympic at some unknown draft. The actual displacement at 34½ ft. is a little over 52,000 tons.

In discussing steering, on page 104, there is given as a reason for fitting the "Dreadnought" with double rudders, that "fitted with a single rudder her turning circle would have had a diameter in the neighborhood of four times her length, and it would have been difficult for her to have maneuvered in company with other battleships with very much smaller turning circles." Recent American battleships, longer than the "Dreadnought" and more than half as large again in designed displacement, have turning circles only about three times their length and accomplish this with single rudders.

In the final chapter is information as to the cost of various ships, prefaced with a statement that "the costs for hull and armor are grouped together so that information as to separate costs is not available." This is the practice in English official statements and effectively discourages detailed analysis of British warship costs or comparison with costs in other countries.

The author does not point out that the costs he gives for hull and armor do not include all of the armor. As indicated by him on page 55, the costs of main gun mountings in English official statements include so called gun shields, which are really turrets and carry heavy armor, so that the cost of a very substantial portion of the armor is charged in the tables to main gun mountings.

This little book, while of interest to the engineer and naval architect, has no value as a work of reference for them. Its avowed purpose is to enable the general reader to obtain some acquaintance with the modern warship and this is well accomplished.

DIAMANTBOHRUNGEN FUER SCHUERF- UND AUFSCHLUSSARBEITEN UEBER UND UNTER TAGE—By Georg Glockemeier. 5¾x8½, pp. 58, illus.; 1.60 marks. Julius Springer, Berlin, Germany.

This little pamphlet covers, in a brief way, the art of core boring with the diamond drill. Sections 1 and 2 describe the operating and feeding mechanisms; section 3 describes the process of setting the stones in the bit, mentioning one method not employed in America, for which several advantages are claimed. The next sections, on driving mechanisms and mountings, are very incomplete, but that on the applications of the drill to mine prospecting is better. The book adds nothing to the knowledge already possessed by most drill runners, and is not sufficiently exhaustive nor discriminatingly representative to be of great value to students.

That forests are an important factor in the humidity of distant regions and therefore should be conserved from that viewpoint is the thesis of a paper in "Science" for July 18, by Dr. Raphael Zor. The paper is entitled "The Relation of Forests in the Atlantic Plain to the Humidity of the Central States and Prairie Region."

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A New Treatise on Thermodynamics

Reviewed by C. R. RICHARDS*

ENGINEERING THERMODYNAMICS—By Charles Edward Lucke, Professor of Mechanical Engineering, Columbia University. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xxiv + 1185; 328 text illustrations. $5, net.

From the amount of the output, one is forced to conclude that during the past few years there has been an "open season" for books on thermodynamics. After the publication, nearly twenty-five years ago, of De Volson Wood's, Peabody's and Thurston's books, devoted primarily to the thermodynamics of the steam engine, there was a long period during which no additions were made to the list of American treatises on thermodynamics. During recent years, however, there have been published a considerable number of books, devoted to this highly interesting and important science, and presenting various methods of treatment of the subject ranging from the highly practical to the severely theoretical. The latest and by far the most important and exhaustive book on the subject written in this country is Dr. Charles E. Lucke's "Engineering Thermodynamics," a volume containing over twelve hundred pages, with no unnecessary illustrations or padding, weighing almost five pounds, which is a veritable cyclopedia of the science.

The book has been prepared primarily for use in the author's undergraduate and graduate classes at Columbia University, and he explains in the preface that certain portions of each chapter will be covered by his undergraduate, and the remainder by his graduate students. While this scheme would no doubt be an excellent one in those few institutions where a considerable number of students remain for advanced study, it will have little weight in determining the selection of the book for use in the great majority of the colleges. The cost of the book, its size and weight and its completeness unfit it for general adoption as a textbook in undergraduate classes. As a general reference book, however, it will be widely used. For students' use, an India paper edition would surely be appreciated, if the single volume is retained in future editions.

The size of this volume and the complicated nature of the subject matter makes it a particularly difficult book to review. A single reading of the book, no matter how carefully done, will fail to reveal all of its points of excellence or all of its defects. A really just estimate of its worth could come only after the careful study and detailed analysis of the subject matter which would be required through its use with a class.

In his treatment of the subject, the author states it "naturally divides into three general parts: the first dealing with the conditions surrounding the doing of work without any consideration of heat changes; the second, heat gains and losses without any reference to work involved and the third, transformation of heat into work or work into heat in conjunction with changes in the condition of the substances," and "accordingly the six chapters of the book treat these three parts in order. The first three chapters deal with work without any particular reference to heat, the second two with heat without any particular reference to work, while the last is concerned with the relation between heat and work." While this division of the subject matter is not illogical, the reviewer questions the wisdom or desirability of the rigorous separation of the first and third parts of the book, and the avoidance in the former of all reference to the first law of thermodynamics. It is important that at the beginning of his study of the subject the student be made to realize fully the inter-relation between heat and work, but in this book he may be required to read nearly nine hundred pages before the discussion of this inter-relation is undertaken.

The first chapter, Work and Power, presents an excellent discussion of the fundamental definitions of work and power, followed by an unusually complete analysis of the work done by a gas expanding along a polytropic curve or path. Every form of the work equation is derived, making the section convenient for reference, but leaving nothing to stimulate the analytical powers of the student, as would be the case if he were required to derive some of these formulas. The author devotes considerable space to the calculation of the clearance volume of cylinders, assuming the equation of the expansion line of the gas to be $P V^s = C$ and that s (why not the usual n?) is known. Since in practice s is not known and its value cannot be determined analytically except when the clearance is known, the analysis given seems to be superfluous. Assuming s to be constant for any expansion or compression curve when there is no leakage, Clayton and Cardullo have each devised graphical methods for finding the clearance from actual indicator diagrams, which give surprisingly accurate results. Following some discussion of the determination of mean effective pressures and of indicated and brake horsepower, there is an interesting derivation of the formulas for the flow of gases through nozzles, using the pressure-volume method.

The second chapter, The Work of Compressors, is perhaps the most exhaustive analysis of the reciprocating compressor ever written. Eight standard reference diagrams are assumed, four for single-stage, and two each for two- and for three-stage compressors, as follows: For the single-stage, isothermal compression with and without clearance and exponential compression with and without clearance; for the two-stage, exponential compression with and without clearance and with, in each case, the best receiver pressure and perfect inter-cooling; and for the three-stage, exponential compression with and without clearance and with, in each case, the best two receiver pressures and perfect inter-cooling. Each of these cycles is fully analyzed and formulas for work, mean effective pressure and horsepower are calculated and discussed, permitting the ready solution of problems when the equation of the compression and expansion curves is assumed. Reasons for the divergence of the real from the ideal cycle are explained and several possible standards for the computation of the efficiency of compression presented. Of these none seems so logical as that which compares the real work done with that which is done during an isothermal compression. There is a good discussion of the various systems for controlling the discharge from compressors, and the chapter closes with a description of a series of ingenious graphical diagrams for the solution of compressor problems.

Even more elaborate than the chapter on compressors is the one devoted to the work of piston engines, over two hundred pages being required to present a series of exhaustive analyses of hypothetical simple and multiple-expansion engines, covering a variety of typical reference cycles for each type. For the simple engine, the cycles are assumed with hyperbolic and exponential expansion and compression lines, with and without clearance. Similar cycles for multiple-expansion engines are analyzed, with the additional condition that the receivers may be of either infinite or finite capacity. The formulas resulting from these analyses are formidable affairs, which after their derivation are of doubtful value for practical use. Since it is impossible to predict the equation of the expansion and compression lines, or to estimate the probable actual steam consumption except from experience with engines of similar types, graphical analyses are likely to give at least as satisfactory results as can be obtained from analytical analyses, and they are simpler to use. The author presents a brief discussion of cylinder condensation, with a few of the empirical formulas which have been devised to calculate the quantity of the missing steam; and he explains Willan's law of total steam consumption and its applications.

Chapter IV, Heat and Matter, containing 245 pages, including 73 pages of tables, gives an excellent presentation of the nature of heat and its effects, both physical and chemical, and a critical discussion of thermometry, specific heats, coefficients of expansion, so called perfect and real gases, the relation between gas density and molecular weight, the properties of various important saturated and superheated vapors, gas and vapor mixtures, absorption of gases by liquids and their adsorption by solids, combustion and heat transmission. The author gives the latest physical and chemical data, much of which have not previously been readily available for the use of the engineer, and points out the applications of these data in practical work. For example, the information relative to the absorption of ammonia by water is of direct aid to a better understanding of the cycle of the absorption refrigerating process; and that relating to the liquid hydrocarbons should be of assistance in the design of carburetors.

Heating by Combustion discusses the origin and the transformation of heat into useful forms, including the direct combustion of solid, liquid and gaseous fuels. There is a good description of the nature and origin of the natural fuels, of their classification and their physical and chemical properties. The distillation of solid and liquid fuels and the nature and properties of the distillates and byproducts are given attention. In view of the importance now attached to the manufacture of producer gas, the sections devoted to this subject are of peculiar interest. The chemical and thermal changes occurring in the production of air and blast-furnace gas and of producer gas are given in detail. Boudouard's and Clement's determinations of the effects of temperature and time of contact on the equilibrium relations between CO, CO_2 and C and their probable significance in the production of producer gas are mentioned. The author proposes that a "producer horsepower" be defined as the production of an amount of gas per hour yielding upon combustion, 10,000 B.t.u. (low

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heating value), this figure being based upon the average heat consumption per horsepower per hour in large gas engines. Since there is no accepted rating of gas producers, the suggestion for a producer horsepower is an excellent one. There being, however, no generally accepted definition of "low-heating value" the use of the term always leads to some uncertainty. The sections of the chapter devoted to the combustion of gases, explosibility, rates of flame propagation, heat suppression, ratios of air and gas mixtures and the analysis of the thermal action in the steam boiler are well presented and contain material of much value.

The last chapter in the book contains the discussion on heat and work, which, normally, constitutes the principal portion of textbooks on thermodynamics. The author briefly defines the relations between heat and work, thermal processes, thermal cycles, etc. Fortunately for the student, no attempt is made to define entropy. It is given physical significance as the abscissae on a diagram whose ordinates are absolute temperatures and whose areas are heat units. The importance of the entropy-temperature diagram is properly emphasized and throughout the chapter, various forms of such diagrams are given to aid in the conception of thermal processes and cycles, and in the solution of concrete problems. The fundamental thermodynamic equations for gases and for saturated and superheated vapors are derived and discussed. The presentation of these sections is unconventional, and it may be confusing, since there is not the usual separation of the matter relating to gases from that devoted to vapors. The Rankine and the Carnot cycle efficiencies for vapors are derived and the analogy between the work producing jet velocity and the work of the Rankine cycle is shown. The sections devoted to the analysis of the various ideal cycles of internal-combustion engines, to the actual performance of steam engines and turbines and to the flow of gases and vapors through orifices, nozzles and in pipes are excellent. The importance of the refrigerating processes would seem to warrant a more complete discussion of the subject than is presented.

Throughout the book the author shows the practical applications of the text through the aid of numerous solved examples, and at the same time he gives a large number of problems to be solved by the reader. The book contains an unusual number of graphical diagrams which are helpful in giving a physical conception of the matter presented, or in the direct solution of problems; and it contains a large number of interesting and valuable tables, not ordinarily found in such books.

The usefulness of the book to students engaged in research work in thermodynamics is seriously impaired by the absence of a bibliography, or of any direct reference to the sources from which information has been obtained. Since the book contains so much of value to the advanced student, it is to be hoped that this defect will be remedied in future editions.

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Out-of-Date Census Statistics

GENERAL STATISTICS OF CITIES: 1909—Including Statistics of Sewers and Sewage Disposal, Refuse Collection and Disposal, Street Cleaning, Dust Prevention, Highways, and the General Highway Service of Cities Having a Population of Over 30,000. Prepared under the supervision of Le Grand Powers, Chief Statistician for Finance and Municipal Statistics. Washington, D. C.: Bureau of the Census. Paper; 9x12 in.; pp. 197.

Why does the federal government, after spending thousands of dollars in the painstaking collection and compilation of statistics, delay their publication until they are so old as to be almost useless? The volume of municipal statistics before us is a particularly flagrant instance of money wasted through seemingly inexcusable delay, since the value of a large part of its contents depends upon how nearly they represent conditions at the time of publication. The figures presented are four years old and so are chiefly of historical interest. In fact, for the thousands who might have used the statistics had they been published promptly only a few will ever even consult them at all and most of the few will turn from them with disappointment if not disgust.

Having partially relieved our minds of the impatience caused by seeing 1909 statistics in a volume with a 1913 imprint we may express approval of the departure from previous practice in printing these general statistics separately instead of combining them with the vast mass of financial statistics, as heretofore. Aside from this change the 1909 information is an improvement over that given for 1907 and earlier years in that it is fuller in some particulars and probably more accurate, both qualities depending alike upon improvements in the original sources of information and the work of the census agents. Many gaps still exist, due to the failure of our cities to keep records which are absolutely essential to the intelligent and economical administration of their public works.

In view of the poverty of municipal records and the difficulties and delays incident to collecting and publishing municipal statistics in accordance with so ambitious a plan we venture to suggest that the Census Bureau adopt a much simpler plan, covering a much larger number of cities and possibly a wider range of physical statistics. A much less bulky volume than even this modest one, and one far more easily produced, might be issued yearly and prove far more useful—at least for a few years to come. Meanwhile the improvements now being made in municipal records would make it relatively easy to get out a volume along the lines of this one when the proper time came.

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THE WATER WORKS DIRECTORY AND STATISTICS, 1913, Including Alphabetical Index of Officials, and List of Associations of Water Engineers. 30th issue. London, England: Hazell, Watson and Viney, Ltd., 52 Long Acre, W. C. Cloth; 6x9 in.; pp. 497. 10/6, net.

The thirtieth issue of this Directory gives the information most in demand for the water-works of England, Scotland, Wales and Ireland, and for a few foreign works in private ownership which have offices in London. Aside from the officials, the volume gives the date the works were established, their ownership, cost, source, character and mode of supply, population supplied, municipal death rate, total annual and per capita daily consumption, miles of mains and number of meters, and the rates charged for water. In many instances water analyses are given. We continue to miss what could be easily prepared and would be useful to many, namely, a summary of the number and ownership of the works in each of the geographical divisions.

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WATER-WORKS OF CANADA—Compiled by Leo G. Denis, Hydro-Electric Engineer. Ottawa, Ont.: Commission of Conservation; James White, Secy. Cloth; 7x10 in.; pp. 108; illustrated.

The Canadian Commission on Conservation deserves commendation for collecting and publishing this handy directory and description of the water-works of Canada. If our Census Bureau would do the same for the United States the resulting volume would be of far greater usefulness than many of the special reports and bulletins which it now issues. The Canadian volume gives, by provinces, the population of the municipalities included, ownership of works, source and mode of supply, figures on reservoirs, mains, services, pressure, consumption, cost, maintenance, revenue and charges for water. Finally, the name of the officer in charge is given. There are a few useful summaries by provinces.

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A new monthly journal called "The Fire Engineer," made its appearance in August (1 Broadway, New York City; Goodwin Lee, Editor). The journal will be devoted to "every phase of the fire hazard protection," including "prevention, extinguishment, water and chemicals."

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A monthly Australian engineering journal devoted to all phases of civil, mechanical and electrical engineering made its appearance in August, 1913, under the name of "The Commonwealth Engineer," (90 William St., Melbourne, and 273 George St., Sydney, Australia; 6½ shillings, plus foreign postage). The first number is creditable in appearance and contents and gives promise of fulfilling its announced object, which is "to meet the demand that exists for a high-class engineering journal" useful "to the profession at large and to Australian engineering in general."

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The first number of an international and polyglot monthly magazine for contractors appeared under date of August, 1913. The name of the journal, in English, is "The International Construction" and it is described as the "official organ of the International Federation of Building and Public Works Contractors," an association which seems to be restricted so far to continental Europe. The articles are mainly in French, with translated abstracts of many into English, German, Dutch and Italian. They are devoted to large contracting operations the world over, with a fair representation of discussions of labor questions. The publishing office is 20 Rue Neuve, Brussels, Belgium.

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The Institution of Municipal and County Engineers (92 Victoria St., London, S. W., England) has established a "Journal" in which will appear not only the papers read before the Institution but also other papers and current in-

formation. Thomas Coles, the long-time secretary of the organization, is editor of the "Journal." The first number is dated July. There will be 16 numbers a year; 12 monthly numbers and midmonthly issues in April, May, June and July. Advertisements are carried, which may partly explain the disapproval of the venture expressed by some of our London contemporaries in the municipal field. The local price of the first issue of the "Journal" is 1½ shillings.

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A "Bibliography on Valuation of Public Utilities" fills 60 closely-printed pages of the "Proceedings of the American Society of Civil Engineers" for August, 1913. It was originally prepared (May, 1912) by the library staff of the Society for the use of the Society's Committee on Valuation of Public Utilities, but "has been brought uptodate."

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN IRRIGATION FARMING—By W. H. Olin, Director of Agricultural Extension, University of Idaho. Chicago, Ill.: A. C. McClurg & Co. Cloth; 5x8 in.; pp. 364; illustrated. $1.50, net.

COAST EROSION AND PROTECTION—By Ernest R. Matthews, Borough Engineer of Bridlington (England); author with Prof. Hy. Adams of "Reinforced Concrete Construction" and with T. G. Howes Thomas of "Logarithms and Trigonometry for Engineers and Surveyors." London, England: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; xiv + 147; 74 text illustrations and 34 plates. $3.50, net.

CONSERVATION AND DISTRIBUTION OF WATER FOR IRRIGATION—Bulletin W-204. New York City: Henry R. Worthington Hydraulic Works, 115 Broadway. Paper; 6x9 in.; pp. 77; illustrated.

While devoted primarily to various kinds of centrifugal pumps made by the company named, this pamphlet contains a considerable amount of general information in text and tabular form on pumping for irrigation, besides giving plain directions for installing pumps.

ELECTRICITY IN MINING—By Siemens Brothers Dynamo Works, Ltd., London, England: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 8x11 in.; pp. xiv + 201; 190 illustrations. $3.50, net.

ELEMENTARIES, VERBALS AND DRAWING FOR MARINE ENGINEERS; Being Part II of Griffin's New Guide to the Board of Trade Examinations for First and Second Class Engineers—By R. A. McMillan, Head Engineering Master, Bootle Technical School. London, England: Charles Griffin & Co., Ltd., Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 6x9 in.; pp. viii + 323; 259 text illustrations and 30 page and folding drawings. $3.75, net.

ELEMENTS OF WATER BACTERIOLOGY, with Special Reference to Sanitary Water Analysis—By Samuel Cate Prescott, Associate Professor of Industrial Microbiology, Massachusetts Institute of Technology, and Charles-Edward Armory Winslow, Associate Professor of Biology, College of the City of New York and Curator of Public Health, American Museum of Natural History. Third edition, rewritten. New York: John Wiley & Sons, Inc. London, England: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xiv + 318. $1.75, 7/6, net.

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UBER NEUERE THERMODYNAMISCHE THEORIEN (Nernstsches Warmetheorem und Quantenhypothese)—By Dr. Max Planck, Professor der theoretischen Physik an der Universitat Berlin. Vortrag gehalten am 16. Dezember, 1911, in der Deutschen chemischen Gesellschaft in Berlin. Leipzig, Germany: Akademische Verlagsgesellschaft m.b.H. Paper; 6x9 in.; pp. 34. 1.60 Marks.

VICTORIAN INSTITUTE OF ENGINEERS—Proceedings, Vol. XII. Melbourne, Australia: The Institute, 57-59 Swanston Street. Cloth; 6x9 in.; pp. 257; illustrated.